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SUMARIO ● SUMMARY ● RESUMO

Editorial

In the current context, marked by large-scale social, technological and environmental transformations, it is essential to review and strengthen the frameworks from which education is conceived. This edition gathers eight contributions that, from diverse disciplinary and methodological perspectives, address relevant issues for the advancement of educational quality and the construction of applied knowledge.

It begins with a review of the Education for Sustainable Development (ESD) approach, understood as an integral and transversal educational process that enables people to identify and act in the face of contemporary socio-environmental challenges. ESD promotes the acquisition of fundamental values, knowledge and skills at all levels of education, particularly those related to the Sustainable Development Goals (SDGs). The work emphasizes the need to integrate sustainability in a systemic way in formal education, articulating the efforts of citizens, companies and public institutions.

The second study examines the scientific production in environmental sciences of a private university in Peru, through bibliometric analysis of articles indexed in Scopus between 2013 and 2024. The findings show a sustained growth in academic publishing, with special concentration in the years 2022 and 2023, and a high presence in impact journals (Q1 and Q2). The research allows the identification of authors, journals, recurrent topics and collaboration networks, which provides strategic information for the institutional strengthening of research on environmental issues.

The third contribution offers a systematic review of Project Based Learning (PBL) and its impact on the development of social science competencies in secondary education in Colombia. The results show positive effects of PBL in the development of critical thinking and historical analysis, although gaps are also identified in longitudinal studies and in the alignment between this methodology and national assessment standards, such as those of the ICFES. A greater contextualization of PBL and the design of specific evaluation tools to measure its real impact on key competencies are suggested.

The following study addresses the relationship between musical training and cognitive functions in adolescents, specifically verbal working memory. Based on a comparative design, significant differences were found in favor of the group with musical training in standardized tests of verbal comprehension and *digit span*. Although no broad effects on other executive functions were observed, the data support the inclusion of music programs as part of cognitive development in school populations.

In addition, the relationship between nutritional status (measured by BMI and hemoglobin) and cognitive processes affecting academic performance in adolescent students is explored. The results show a weak association between nutritional variables and school performance, both in grades and neuropsychological tests. However, it warns about risk factors in eating habits and points out the need for integrated preventive strategies that address health and education in a coordinated manner.

Another contribution focuses on a conceptual proposal of pedagogy for global citizenship, based on a critical documentary review. There is an urgent need to train individuals capable of interacting with empathy, ethics and critical thinking in culturally diverse contexts. The pedagogy of global citizenship is projected as a way to strengthen the social fabric, based on reciprocal recognition and the promotion of universal values aimed at social justice and democratic coexistence.

The journal continues analyzing the level of mastery of digital competencies in

secondary education teachers. Although high levels of theoretical knowledge are identified, practical application in pedagogical settings presents limitations. The results suggest the need for specific training programs focused on the effective integration of digital tools in teaching-learning processes, under active methodological approaches.

Finally, a study on the impact of artificial intelligence-mediated personalized feedback on formative assessment in higher education is presented. Through a mixed design, perceptions and results of students on digital platforms are analyzed. It is concluded that individualized feedback improves motivation and meaningful learning, although challenges remain in its scalable implementation. The study provides strategies for optimization and suggests considerable potential for artificial intelligence to support teaching practice.

Taken together, the papers collected here offer a critical and up-to-date overview of key issues for the contemporary educational agenda, highlighting the need for interdisciplinary approaches and contextualized pedagogical solutions.

Antonio Pantoja Vallejo
Editor Jefe / Editor in chief / Editor Chefe

Education for Sustainable Development: Its relevance in fostering student commitment to sustainability

Educación para el Desarrollo Sostenible: su relevancia para fomentar el compromiso del alumnado con la sostenibilidad

Olga González-Morales
University of La Laguna, Spain (olgonzal@ull.edu.es) (https://orcid.org/0000-0002-3754-2300)
Lidia E. Santana-Vega
University of La Laguna, Spain (santana@ull.edu.es) (https://orcid.org/0000-0002-2543-6543)
Milena Trenta
University of La Laguna, Spain
(mitrenta@ull.edu.es) (https://orcid.org/0000-0002-2987-2051)

	ABSTRACT
Keywords: education, sustainable development, civic participation.	Education for Sustainable Development (ESD) is a lifelong process of acquiring values, knowledge, and skills in childhood, youth, and adulthood so that people are able to find solutions to the socioeconomic and environmental problems that affect them. It is understood as a holistic and transversal education for all stages and levels of education. Its main objectives are to provide knowledge, improve skills, and develop positive attitudes in students regarding sustainable development. Students are made aware of the role of citizens, businesses, and public administrations in finding solutions to the various problems facing the countries and their institutions around us. ESD plays an important role in disseminating the concepts associated with the Sustainable Development Goals (SDGs). On the one hand, students must be aware of the SDGs being developed in many countries, especially in European countries, and, on the other, they must know how citizens, businesses, and public administrations could contribute to achieving them. This article raises some questions about specific aspects of ESD and presents some results from the European ECCOPS project focused on these topics.
	RESUMEN
Palabras clave: Educación, desarrollo sostenible, participación cívica.	La Educación para el Desarrollo Sostenible (EDS) es un proceso a lo largo de la vida de adquisición de valores, conocimientos y habilidades en la infancia, la juventud y la edad adulta para que las personas sean capaces de encontrar soluciones a los problemas socioeconómicos y ambientales que les afectan. Se entiende como una formación holística y transversal para todas las etapas y niveles educativos. Sus principales objetivos son proporcionar conocimientos, mejorar habilidades y desarrollar actitudes positivas en el alumnado sobre desarrollo sostenible. concienciando sobre el papel de la ciudadanía, las empresas y las administraciones

públicas en la búsqueda de soluciones a los diversos problemas que afrontan los países que nos rodean y sus instituciones. La EDS desempeña un papel importante en la difusión de los conceptos asociados a los Objetivos de Desarrollo Sostenible (ODS). Por un lado, los estudiantes deben ser conscientes de los ODS que se están desarrollando en muchos países, especialmente en los países europeos, y, por otro, deben saber cómo los ciudadanos, las empresas y las administraciones públicas podrían contribuir a la consecución de los ODS. Este artículo plantea algunos interrogantes sobre aspectos específicos de la EDS y presenta algunos resultados del proyecto europeo ECCOPS centrado en estos temas.

Introduction

As a result of the various crises that have occurred at the beginning of the 21st century, there is a growing need to reconsider the values on which the current development model is based. Achieving a certain level of economic growth coordinated with social progress and environmental protection seems to be the most appropriate path to sustainable development. The lines of public action aimed at families, companies and public administrations help in this process, with actions aimed at the educational system being of particular relevance. Governments set objectives and public institutions can adopt four positions: regulate, facilitate, collaborate and promote (Fox et a., 2002).

Since 2005, UNESCO (n.d.) has emphasized that Education for Sustainable Development (ESD) requires lifelong learning to acquire the values, knowledge and skills necessary for children, youth and adults to seek new solutions to current problems. It is understood as a holistic and transversal training that should be incorporated in all educational stages and levels. One of the most important objectives is to transmit knowledge, enhance skills and develop positive attitudes in students towards sustainable development. Awareness must be created of the role of citizens, companies and public administrations in the search for solutions to the different problems faced by the countries of our environment and their institutions.

The purpose of this article is to reflect on these issues. It analyzes the state of the art on the subject of sustainable development, the way in which the Sustainable Development Goals (SDGs) are introduced as tools for raising awareness and the consideration of ESD from the coordinates of civic education. The aim is to provide guidelines on how to structure the learning of these concepts in the classroom, define the key competencies that students should learn in this regard, and describe the role that youth participation plays in this process. Thus, the following research questions are posed.

How can the concept of sustainable development be integrated into educational curricula?

How have the SDGs influenced the conceptual and methodological evolution of ESD?

To what extent does civic education contribute to the development of key competencies for sustainability?

How do teachers approach ESD in the classroom?

What does the ECCOPS project contribute to the teaching of active citizenship and sustainability?

How does the multiperspective approach contribute to the prevention of radical attitudes among students within the ECCOPS project?

State of the Art

The publication of the SDGs has brought about a change of direction in ESD, addressing the issue from a comprehensive and multidimensional perspective. The 2030 Agenda proposes 17 SDGs, including the goal dedicated to Quality Education (SDG 4), which seeks to ensure inclusive, equitable and quality education and promote lifelong learning opportunities for all. Different sub-objectives are proposed in this regard, highlighting sub-objective 4.7, which focuses on ensuring that, by 2030, students acquire the necessary theoretical and practical knowledge on sustainable development that will lead to new lifestyles (INE, n.d.).

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While there are numerous definitions of ESD (Murga-Menoyo, 2021), it is UNESCO that has established the dominant approach, promoting it since 1992 through notable interventions such as the UN Decade of ESD 2005-2014 (UNESCO, 2005), the Global Action Programme on ESD 2015-2019 (UNESCO, 2014) and the ESD 2030 Agenda (UNESCO, 2019; 2020).

ESD represents an evolution and an extension of what was defined in the past as environmental education (Baena-Morales & Ferriz-Valero, 2025). The latter, from its origins, was involved with ecological, social and economic approaches that proposed a development respectful of the biosphere and social equity (Novo, 2009). However, the development of these concepts has been heavily criticized for their limited progress towards sustainability (Bautista-Cerro et al., 2019). The most recurrent criticisms focus on its ambiguity, derived from its broad perspective, and the changing nature of sustainability issues. For greater specificity, UNESCO (2020) proposes to refer explicitly to the SDGs and considers that all ESD activities contribute to their achievement. Other critics question the need to qualify education and the neglect of its intrinsic value for human development, and propose rethinking the SDGs as a tool at the service of education (Carrillo et al., 2018). Reyero and Gil (2019) point out that what is relevant about the SDGs is that they improve the concept and practice of education, considered an essential part of human development.

There are other terms with similar meanings to ESD, such as education for development, education for a sustainable future, education for sustainability and education for the SDGs, although they have some differences in terms of themes, objectives and methodologies. Guevara-Herrero et al. (2023) conducted a bibliometric study on how environmental education has been approached and provide a broad overview of the evolution of the term.

This article uses the term ESD because it represents a comprehensive and transformative approach to education that incorporates formal, non-formal and informal education throughout a lifelong learning process. ESD contributes to the training of professionals capable of meeting the challenges of forming citizens with ethical awareness and civic responsibility, who think critically and act sustainably (De la Rosa et al., 2019; Jucker & Mathar, 2015; Kyburz-Graber, 2013; Michelsen, 2015). To be agents of change and transform society, people must first transform themselves (Alonso-Sainz, 2021; Boni et al., 2012; UNESCO, 2017).

In short, the aim is to ensure that schools' educational projects integrate ESD in line with the European strategy. In this sense, the role of the center's management team is fundamental, establishing specific annual objectives and informing and training teachers, who must design curricula consistent with the objective proposed by the center (Acud et al., 2025; Hamid et al., 2025).

ESD from the Coordinates of Civic Education

In Europe, citizenship education is part of the curriculum of non-university educational institutions. Through this course, students acquire knowledge and skills related to citizenship, as well as practical experience in activities within the educational institution or the social field. Citizenship education helps students understand that they are part of multiple communities (local, national, European and global). It also seeks to equip students with skills that promote their community interests, fostering harmony in their development (Bombardelli et al., 2014; Damiani & Fraillon, 2025; European Commission/EACEA/Eurydice, 2017; Santana Vega & Feliciano García, 2017; Santana-

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Vega et al., 2021). The teaching of concepts and skills related to sustainable development is, to some extent, linked to citizenship education.

There are numerous national and international initiatives by educational institutions to implement sustainability in teaching, research, social leadership and governance (Alcaraz and Alonso, 2019; IAU, 2020; Miñano and García-Haro, 2020; SDSN Australia/Pacific, 2017). A first step in demonstrating institutional commitment involves incorporating sustainability competencies into teaching projects (Wiek et al., 2011), helping students achieve the learning outcomes needed to meet the SDGs (unesco, 2017) (UNESCO, 2017). Many universities are working on the inclusion of sustainability in the curriculum, examining the presence of sustainability competencies in the curricula and proposing tools to assess the acquisition of these competencies (Azcárate et al., 2016; Bautista-Cerro and Díaz, 2017; Murga-Menoyo and Novo, 2015; O'Byrne et al., 2015; Segalas and Sánchez, 2019). They also focus on teaching-learning strategies and methodologies (Busquets et al., 2021) (Busquets et al., 2021).

At the curricular level, the integration and assessment of sustainability competencies is complex, due to the diversity of proposals (Azcárate et al., 2016; Aznar et al., 2013; Rieckmann, 2012). This complexity influences the limited presence and assessment of sustainability competencies in university studies (Bautista-Cerro and Diaz, 2017; Murga-Menoyo and Novo, 2015). Considering the holistic view of sustainability from the perspective of the SDGs, a simpler instrument has been developed to assess the acquisition of sustainability competencies, which has been incorporated by a small number of Spanish universities (Albareda-Tiana, 2018).

The integration of social competency learning outcomes into curricula is even more scarce and poorly developed. The UNESCO (2017) proposal establishes learning outcomes for all SDGs according to three levels of mastery: the cognitive domain (understanding and acquisition of knowledge related to the SDGs and sustainability, thinking tools and exploration of disruptive ideas and alternative solutions); the socioemotional domain (social skills that enable students to collaborate, negotiate and communicate); and the behavioral domain (skills that put into practice transformative actions in favor of sustainability, related to the individual and social spheres). Considering that teaching actions should be evaluated to ensure a real contribution to sustainability (UNESCO, 2014), these learning outcomes could constitute the benchmark for assessing practices for introducing knowledge of the SDGs. At the instrumental level, ESD requires the adaptation of teaching-learning strategies. The types of learning should be learner-centered (participatory and collaborative), based on real problems and adopt a critical approach.

It is clear that there is room for improvement in the teaching area, as is confirmed by the CRUE-Sustainability-GESU (2021). This assessment is also shared by Spanish university students. Students consider that the training received in sustainability is insufficient to apply it to the professional field (Valderrama-Hernández et al., 2020) and that sustainability competencies are not adequately worked on (Segalas and Sánchez, 2019). While progress is being made in the development of homogeneous frameworks and the implementation of formal operational proposals for curricular sustainability, committed teachers are driving voluntary initiatives, whose contribution to learning outcomes must also be evaluated.

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How to Approach the Learning of Concepts Related to Sustainable Development in the Classroom?

Regardless of the level of education at which ESD is taught, it is a priority to teach students to go to the source of the data and not to accept information that does not come from reliable and recognized sources.

First, students should know that the concept of sustainable development is a political concept, developed by the World Commission on Environment and Development, known as the Brundtland Commission (United Nations, 1987). Sustainable development is considered to meet current needs without compromising the ability to meet the needs of future generations. One issue that should be made clear to students is the difference between the concepts of growth and sustainable development. Growth refers to quantitative aspects, while sustainable development also considers qualitative aspects of quality of life in a broad sense.

Second, the focus is on the SDGs. Students should know that the United Nations forum (United Nations, 2015) adopted the 2030 Agenda for sustainable development at the international level to respond to global trends and challenges. It proposes 17 objectives to be met by all countries that have committed to achieving them. In Spain, for example, the National Statistics Institute (INE) lists 17 objectives with 169 targets. To monitor them, 232 indicators were designed that can be measured with the statistical data they collect. These indicators are updated annually. The availability of data in Excel, graphs and analysis documents allows students at any educational level to analyze the status of these indicators. Learning situations will vary according to the level, subject matter and maturity of the students. Collaboration between different subjects enhances the learning of these concepts.

Thirdly, the focus is on the role of companies. They play a key role in changing economic models towards sustainability. It is worth noting that in recent decades, both voluntarily and at the urging of public administrations, an increasing number of companies have included aspects that contribute to it. This contribution is embodied in the actions integrated within what is called Corporate Social Responsibility (CSR) and more and more companies are considering the 17 SDGs as an integral part of their objectives, competitiveness and growth strategies. This results in benefits for business and society at large (European Commission 2019a; 2019b; Kang et al., 2010). Although business decisions are conditioned by economic, social, environmental, technological and political-legal factors of the business environment. In Europe, the European Commission (European Commission, 2001; 2011) defined CSR for the first time in 2001 and has been developing the concept ever since. Students need to know what dimensions and aspects are included in the concept of CSR. Students are invited to reflect on the internal and external dimensions of the company. In the internal dimension, students think about the actions that the company can take in aspects related to human resources management, occupational health and safety, adaptation to change and management of environmental impact and natural resources. In the external dimension, they discuss how the company can take measures that contribute to the development of the local community where it is located, how to collaborate with partners, suppliers and consumers, actions related to respect for human rights (adoption of codes of conduct) and how companies can help mitigate certain global ecological problems. Individual or group exercises can be performed.

Fourth, how public administrations can contribute to sustainable development can be analyzed in the classroom. In this case, a two-pronged approach is observed. On the one hand, public administrations that act in a socially responsible manner are an example

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of good practice for the business sector. On the other hand, public administrations can encourage socially responsible actions by companies (awards, quality certificates, etc.); they can also create open meeting spaces where companies can share their good business practices (forums, websites, etc.).

Fifth, in relation to consumer behavior, it is necessary for students to know what the circular economy is. The European Parliament (European Parliament, 2023) considers it a model of production and consumption that involves sharing, renting, reusing, repairing, renewing and recycling existing materials and products for as long as possible. It is necessary to consider the role of the traditional linear economic model, based on the pattern of take, make, consume and throw away. Planned obsolescence is also part of this model, i.e. when a product has been designed with a limited useful life to encourage consumers to buy it again. As a result of the above, classroom practices focus on responsible consumption, understood as the attitude of consumers towards conscious and critical consumption. Being a socially responsible consumer involves:

- Behave responsibly when purchasing products and services
- Be responsible when using products and services
- Evaluate whether products and services are offered by socially responsible companies
- Do not purchase products and services whose production or use negatively affects the environment.

In 2021, the European Commission (European Commission, 2021) launched a commitment to responsible consumption and companies pledged to adopt concrete measures to achieve greater sustainability.

Key competencies of Sustainable Development

Civic competence is related to this topic. It is the result of a complex combination of different learning outcomes derived from different school subjects. It is necessary to analyze how young people can acquire this civic competence and what types of problems can be analyzed in the classroom so that students participate, exchange ideas and practices, learn to document themselves and make motivated decisions.

UNESCO (2014) defines a set of key competencies for sustainable development, focusing on critical thinking, systems thinking, collaborative decision-making and responsibility towards present and future generations. Patta Tomás and Murga Menoyo (2020) state that compulsory secondary education curricula should include the formation of this type of competencies as an educational objective. They compare the competencies required by the official curriculum of the biology and geology subject of the first year of compulsory secondary education and the competencies needed to comply with the United Nations 2030 Agenda. The results show the absence, in the official program, of the concepts of sustainability and sustainable development. There is a marked deficit in systemic competence that affects the acquisition of all other competencies. The effect is a student body capable of understanding concepts, facts and isolated situations, but with insufficient knowledge of the interrelationships that occur in the ecosocial reality, an essential issue for the achievement of the SDGs. It is necessary to reorient the teaching practice that deepens the competency-based education approach. This purpose requires articulating the teaching-learning process with a methodological approach that seeks to integrate knowledge and emotions through the experience of interaction with the context.

Various educational proposals have been presented to promote these skills in compulsory secondary education and high school, using different tools and learning situations. The game is a way to bring these concepts closer to young people. In recent years, gamification has been used in different fields, including education (Gómez

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Trigueros, 2018; Moßbrucker et al., 2025). Gamification is understood as the use of game techniques and strategies in non-game contexts (Deterding et al., 2011) (Deterding et al., 2011). Its effect on student motivation and engagement has been investigated, both at a general level (Alsawaier, 2018) as well as on topics such as climate change and sustainability (Ouariachi et al., 2018; Wu & Lee, 2015). It has been concluded that they are educational tools that promote participation and engagement. González-Robles and Vázquez-Vílchez (2022) present a board game type educational resource used with secondary school students to contribute to the education and knowledge of environmental issues through the SDGs. In addition, they evaluate the ability of the game to enhance motivation and generate commitment to the environment in students.

All of the above requires that teachers take training courses to guide them in their pedagogical work. This training should be aimed at in-service and future teachers, and it is advisable to use an interdisciplinary and ecosystemic approach (Lateh & Muniandy, 2013; Matos & Flores, 2020). Matos Meléndez (2022) analyzed the influence of environmental education on the perception of sustainable development in secondary school teachers and found that it has a significant influence. Social integration, social contribution, social actualization and consistency significantly influence teachers' perception of sustainable development, but not social acceptance. Examples of initiatives implemented can be found in López Esteban (2022), an author who analyzes the importance of teacher training and proposes zero MOOC courses on education and SDGs.

Sustainable Development and Youth Participation

The participation of young people in political life and institutions is a fundamental factor in building more sustainable societies. Young people can be key agents of change through education and their familiarity with technology. New forms of social organization and interaction, such as social networks, so popular among the younger generations, can be an excellent means of proposing concrete alternatives for achieving the SDGs.

Likewise, citizen participation in favor of the defense and expansion of fundamental rights and collective well-being is the way to reverse political distancing, distrust in institutions and the spread of hate speech (United Nations, 2021). Citizen participation plays a dual role in society. On the one hand, it allows the population to express their opinions and concerns and contribute to the development of policies that affect their lives; on the other hand, it contributes to improve transparency and responsible decision making in public institutions and businesses (Almagro, 2016; Claramunt, 2022).

The participation of young people in the fundamental issues of their community is crucial in a communication scenario where digital networks encourage the global dissemination of simplistic and reductionist messages about complex phenomena. Fake news is not a recent phenomenon. The problem with the dissemination of false information lies in the fact that such information is spread among large audiences through social networks and platforms that facilitate the creation of disinformation bubbles. This generates informative biases and nullifies the desire to contrast the information (Ardèvol-Abreu et al., 2019; Ardèvol-Abreu et al., 2020; Rodríguez-Ferrándiz, 2019).

The European Union, together with the United Nations, makes it clear that promoting youth participation is a key factor in ensuring the advancement of democracies. Therefore, the United Nations has devoted numerous efforts to create specific conditions and tools to involve citizens in the decision-making process and promote a truly participatory democracy (Luena López, 2022; Pérez de las Heras, 2020).

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The climate emergency and the adoption of sustainable consumption patterns are two of the issues in which the European Union is trying to involve citizens, especially young people. The Council of Europe supports youth participation in policy formulation in different fields and in democratic processes at the institutional level, through the Council of Europe Youth Department (https://www.coe.int/en/web/youth), which operates through a co-decision process between youth organizations and representatives of member states. Also, the European Union and the Council of Europe have shown their support for the activities of youth NGOs dealing with environmental measures. However, there is still much to be done in the legislative framework of all member states (Macanović, 2016).

There are numerous experiences that demonstrate how the exercise of citizen participation from an early age favors personal and social change, a greater understanding of the environment, a change in behavioral patterns in relation to the environment and a greater involvement in the real problems of local communities (Boulahrouz, 2021; Letouzey-Pasquier et al., 2025; Moreno Fernández and García Pérez, 2015). But it is not possible to implement specific and successful participation models or mechanisms, if the educational institution and the entire educational community are not rooted in the local context, nor are they involved in local sustainable development. Therefore, it is necessary for the local community and the educational community to activate mechanisms for the participation of schools and students in the construction and promotion of a local sustainability program (Rodríguez-Zurita et al., 2025) (Rodríguez-Zurita et al., 2025).

Development of These Skills in the ECCOPS Project

As an example of the application of the contents developed in the previous sections, the results of the ECCOPS project (Education for Civic Competence, Participation and Sustainability) are presented in summary form. It was funded by the European Commission under the Erasmus+ 2021-2027 Program. Three partners participated: UCIIM-Unione Cattolica Italiana Insegnanti Medi (Italy), University of La Laguna (Spain) and Inspectoratul Académico Buzau (Romania), between 2021 and 2023 (Bombardelli, 2024).

This project is based on the premise that, in order to contribute to sustainable development, citizens of a democratic society must possess civic competence, be able to make informed judgments in the civic-political sphere and make informed decisions. However, there is a large gap between theory and practice in most European countries.

The overall objective of the project was to promote essential competencies for active and responsible citizenship in young people through a special teacher training program. Innovative strategies and tools were developed for teaching civic education in secondary schools. Inclusion, participation and sustainable development were considered from a European perspective. Specifically, the following specific objectives were established:

• To deepen the teaching dynamics of civic and citizenship education.
• Promote an active attitude in students with learning strategies focused on them and attentive to their individual needs.
• Pay attention to the content, cognitive (knowledge, reasoning, application) and affective-behavioral dimensions, especially civic competencies.

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• Promote citizen participation and the assumption of responsibilities among young people by encouraging forms of representation at school and in the community.

• Strengthen the quality of teaching civic education and active citizenship through international cooperation.

The project involved several schools, whose teachers developed a pilot course with their students. Teaching activities were linked to sustainable development and active citizenship. Methodological strategies and evaluation and self-evaluation methods agreed upon by the three partners were used. Classroom work was mutually supervised according to shared criteria and using a toolkit developed by the partners. More information about its development can be found on the project's website: https://eccops.uciim.it/en/project-overview-2/

Tools Developed by the Project's Research Partners

The development of appropriate tools for teaching and learning was a priority. To this end, the partner countries organized training courses for secondary school teachers in the field of civic education and sustainable development (12-hour webinars); a working guide (toolkit) was also published in four languages (English, Italian, Romanian and Spanish) and teaching materials for testing among students in the partner countries (13 hours of classroom work). These materials can be used in different school subjects, especially civics, geography, history, law, economics, religion, art, mother tongue and foreign language, with an interdisciplinary and collaborative approach. The ECCOPS tools, in digital format, are the Toolkit, one for teachers and one for students, the student competency sheets and the teacher competency matrix. These materials are conceived as part of a general school learning offer and do not exclude existing textbooks. Specifically, the partners developed a manual, a teacher's guide with teaching guidelines, a skills matrix and skills cards.

- Manual. It contains the five themes of the ECCOPS project (Human Rights, Global Citizenship, Democratic Citizenship, Sustainable Development and Corporate and Consumer Social Responsibility). The handbook is linked to the student skills cards and guidelines prepared for faculty. The added value of ECCOPS is to link the European dimension with cross-border cooperation, active participation and self-assessment of students with a "multi-perspective" view of the problems. To facilitate inclusive learning, the material was structured according to the main questions: who, what, why, when, where. Learning objectives, outcomes and their assessment are interconnected and integrated, differentiating between the cognitive domain (knowledge and understanding), values, attitudes and the affective-behavioral domain of citizenship (dispositions to actively participate in community life, behavior, actions, practical application and commitment). Teachers can use the manual by choosing what is most appropriate for their national and local context, adapting the materials to the interests and learning level of their students. The manual is designed for use with students in the last years of primary school, compulsory secondary education and, in depth, in the last two years of secondary school (Bachillerato). Civic and citizenship education necessarily involves addressing controversial and sensitive issues at school. Students participate in peaceful debates on controversial issues and accept them as a normal and necessary part of democracy. The "multiperspective" view of controversial issues aims to

prevent and combat forms of radicalism and fanaticism, which feed on emotional states and rigid ideological positions, rather than on knowledge and reasoning.

- Teaching guidelines. These reflect the partners' shared vision on educational styles, monitoring and evaluation strategies for teaching/learning. The target group is secondary school students (13-19 years old), teachers, trainers, headmasters, principals, researchers, school authorities, school policy makers, inspectors, authors and publishers of school books, youth associations and local institutions.
- Competency matrix questionnaire. A tool for teacher self-reflection. This matrix describes the competencies necessary to achieve the best possible teaching quality in the field of Civic and Citizenship Education and ESD, fostering student participation and sustainable development.
- Skill cards. A tool for student self-assessment. Through them, students record and promote knowledge, skills and values that enable them to better understand what constitutes effective civic participation and a commitment to sustainable development. Working with the cards individually provides a framework for students to be aware of their own progress. The indicators on the cards refer to the 2018 EU key competencies and the national standards of the partner country's school systems.

Tools Applied in Schools

The implementation of the topics and the use of the tools by the schools yielded very interesting results.

The pilot course faculty recorded videos of some of the teaching/learning activities conducted in the classroom. Group observation was conducted by peers. The objective of the observation was to improve the approach to Civic and Citizenship Education. The observation of recorded educational work provided an excellent opportunity to exchange knowledge, collaborate, evaluate each other as "critical friends" and improve teaching practice. Nineteen videos were recorded in different Spanish, Italian and Romanian educational centers.

Events were organized to disseminate the good practices developed in the classrooms. At these events, teachers explained their educational experience. The activities were very varied. These include the design of posters on environmental issues, debates on human rights, a short story contest, rap music compositions, talks, meetings with public administrations and testimonials from volunteers dedicated to environmental protection. Recycled materials were also used in handicrafts. First, there was a discussion on how to recycle, and then it was explained to the students how they could make, for example, decorative cushions, pet coats, cell phone covers, etc., and where to get the materials. Each group had to explain how to make the product assigned by the teacher, recycling other old products that could have been discarded. Finally, each group presented their idea to the others and everyone discussed other ways to recycle.

Similarly, World Water Day was used as an opportunity to carry out a learning situation. This learning situation was implemented in different courses and different subjects (Economics and Entrepreneurship, Social and Personal Economics, Plastic, Visual and Audiovisual Education, Geography and History, Spanish Language and Literature, Mathematics, First Foreign Language, Technology and Digitalization).

The simultaneous use of the skills cards helped students to self-assess, which does not involve grading themselves, but working together on assessment criteria and quality indicators. It is important to provide constructive feedback and discuss content, motivations and learning processes with students.

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Conclusions

ESD is proposed as a fundamental tool to face the socioeconomic and environmental challenges of the 21st century. Through holistic and cross-cutting education, ESD seeks to instill values, knowledge and skills that enable people to think of new solutions to the problems affecting our society.

This article highlights the importance of ESD in integrating knowledge of sustainable development into the educational system (formal, non-formal, informal). The 2030 Agenda and its 17 SDGs, in particular SDG 4, dedicated to Quality Education, provide a clear and concrete framework to guide education policies towards sustainability. It is essential that students are aware of the SDGs and understand how they can actively contribute to their achievement. The participation of citizens, companies and public administrations is crucial to achieve these objectives and promote sustainable development.

Despite the criticisms of ESD, its holistic and transformative approach makes it a key element in the formation of citizens committed to sustainability. Education must go beyond theoretical knowledge, fostering awareness and values that empower people as agents of change. Therefore, the effective implementation of ESD in the classroom is an indispensable step to achieve environmentally friendly development and social equity.

The integration of ESD into educational curricula is essential to prepare students as responsible citizens who are aware of their role in diverse communities. The inclusion of sustainability competencies in the curricula is proposed, although their implementation and evaluation present challenges due to the variety and complexity of the proposals. Despite these difficulties, the need to improve sustainability training at all educational stages is widely recognized. While homogeneous frameworks are being developed and formal operational proposals for curricular sustainability are being implemented, committed faculty will continue to promote voluntary initiatives that contribute significantly to sustainability education.

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SCIENTIFIC PRODUCTION IN ENVIRONMENTAL SCIENCES OF A PERUVIAN PRIVATE UNIVERSITY IN THE SCOPUS DATABASE

Producción científica en ciencias ambientales de una universidad privada peruana en la base datos scopus

Alfredo Néstor Salinas Castro
Universidad Científica del sur, Peru(asalinascas@cientifica.edu.pe)(https://orcid.org/0000-0001-5212-6113)

Jaime Marreros Tananta
Universidad Científica del Sur, Peru (jmarreros@cientifica.edu.pe)(https://orcid.org/0000-0002-1025-4288)

	ABSTRACT
Keywords: Bibliometrics, bibliography, environmental data, scientific publications.	The present study seeks to analyze the publications of articles in the Scopus database on environmental issues carried out by a private university in Peru between 2013 and 2024 through a review of bibliometric indicators in which 200 papers were selected and analyzed. The search was conducted by affiliation. The variables analyzed are: author, year, citations, journal, index, language and topics. The results allow us to see that the years 2022 and 2023 had a higher number of publications (n=54 and 52), 2017 reports a higher average total of citations per article (n=78.57), the journal with the most publications is "Marine pollution bulletin" from Switzerland with a Q2, SJR = 0.83, with 20 articles, the most relevant authors are: Alfaro-Shigueto (n=37) and Mangel JC (n=34), the clusters identified show words that are not normally associated with the field of environmental sciences such as: human, clinical study and non-human, the article with the greatest impact is "Microplastics in the Antarctic marine system: An emerging area of research", the countries in which they are published the most are Switzerland, the Netherlands, the United Kingdom, Germany and the USA. The impact level are between Q1 and Q2 with SJR = 0.39 up to 2.15.

	RESUMEN
Palabras clave: bibliometría, bibliografía, datos ambientales, publicaciones científicas.	El presente estudio busca analizar las publicaciones de artículos en la base de datos Scopus sobre temas ambientales realizadas por una universidad privada del Perú entre los años de 2013 al 2024 a través de una revisión de indicadores bibliométricos en las que se seleccionaron y analizaron 200 papers. La búsqueda se realizó por afiliación. Las variables analizadas son: autor, año, citas, revista, indizada, idioma y temas. Los resultados permiten ver que los años 2022 y 2023 tuvieron mayor número de publicaciones (n = 54 y 52), el 2017 reporta mayor media total de citas por artículos (n = 78.57), la revista con más publicaciones es "Marine pollution bulletin" de Suiza con un Q2, SJR = 0.83, con 20 artículos, los autores más relevantes son: Alfaro-Shigueto (n=37) y Mangel JC (n=34), los clústeres identificados muestran palabras

que normalmente no están asociadas al campo de ciencias ambientales como: humano, estudio clínico y no human, el artículo con mayor impacto es "Microplastics in the Antarctic marine system: An emerging area of research", los países en las que más se publican son Suiza, Países Bajos, Reino Unido, Alemania y EEUU. El nivel de impacto es entre Q1 y Q2 con SJR = 0.39 hasta 2.15.

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Introduction

González (2022) mention that the lack of solid knowledge about the importance of scientific production limits the research skills of university students when carrying out their research project or case study. It can be said that there are two factors that negatively intervene in academic training: the first one responds to the internal motivating environment: it invokes the student's desire to excel, goals, and affective needs. The second responds to the external motivating environment: the lack of a sense of collaboration among teachers, lack of technological tools, lack of virtual teaching, absence of political factors, among others. These factors result in motivational and behavioral barriers.

For his part, Cortés (2007) states that science is not done in universities today as it was a few decades ago. The internationalization of research, i.e. the association of researchers from different parts of the world, is becoming the main strategy through which universities face the challenge of redefining their research tasks within a changing context that gives their activities a new dynamic, globalization. It is a fact that the phenomenon of globalization has brought about many changes in the work of universities, particularly in the sectors of research and technological production for industry.

Thus, the international dimension now plays a more significant role within university scientific communities, which is observed when, among their academic tasks, they have to identify their objects of study in an interdisciplinary manner, reorganize their ways of working, use new technologies, be more fluid in their communication, be attentive to new criteria for the evaluation of science or vary the origin of their funding resources (Cortés, 2007).

In a study conducted by Morales-Jasso et al. (2022) mention that environmental sciences combine different disciplines to generate comprehensive knowledge about us and the world around us. The natural and social sciences are not sufficient to address environmental issues; rather, environmental sciences are based on traditional disciplines. The environmental sciences are in search of their distinctive disciplinary matrix, as well as the ethical bases to which they will appeal as they face different environmental problems.

Environmental science publications are essential to advance the understanding of environmental problems, develop sustainable solutions and contribute to scientific knowledge. This allows the scientific community and the public to easily access up-to-date and relevant information on environmental issues.

Scientific publications provide an opportunity for researchers to communicate with each other and to share methods, results and conclusions. This ensures the validity and integrity of the research and the quality of the knowledge shared. New research often builds on the foundations of previous research, ensuring a continuous advancement of knowledge in the field of environmental sciences (Perez and Joaquin, 2024).

Research findings and conclusions can be used to support government decisions related to environmental protection, natural resource management and environmental impact mitigation. Shared knowledge can be disseminated through a variety of means and help raise society's awareness of important issues such as climate change, biodiversity and sustainability. The publication provides a platform to present these solutions and discuss their feasibility, thus promoting the application of science to solve real-world problems (Carden, 2009).

In summary, environmental science publications play an important role in advancing knowledge, fostering collaboration, supporting effective policies, and raising public awareness of environmental problems and solutions.

While environmental issues are important, they may present opportunities or challenges that need to be addressed. Identifying and addressing these areas is critical to a better and more accurate understanding of environmental problems. Although scientific literature is important for the dissemination of knowledge, access to these publications may be limited due to financial constraints. Limited accessibility prevents vulnerable groups and communities from obtaining important environmental information. Environmental research is sometimes fragmented, with different studies focusing on different aspects of the problem without a clear vision. This reduces the understanding of natural systems and the ability to solve problems effectively (Mastrángelo et al., 2019).

Addressing these gaps in environmental science publishing requires a multidisciplinary approach, information gathering, promotion of research diversity, and an emphasis on the validity of reported results to ensure positive outcomes.

Bibliometric analyses on environmental issues play an important role in research and decision making in the field of environmental science and management. On the one hand, it helps to identify trends and areas of emphasis in environmental research. This is critical to foster collaboration and address complex environmental problems that often require multidisciplinary approaches (Gil et al., 2021).

On the other hand, it helps to identify gaps in research by exploring areas that have received less attention or fewer publications. This may lead researchers and funders to areas where more research is needed to improve our understanding of environmental problems (Gil et al., 2021). In addition, information from bibliometric studies can be valuable for policy and decision makers (Gil et al., 2021). In conclusion, bibliometric studies provide a quantitative and objective view of the state of environmental research and can be crucial in determining research decisions and future directions in the field.

According to The Word Universities Insights Limited (2024) the Peruvian universities ranked by research on environmental issues are: Universidad Peruana Cayetano Heredia, Pontificia Universidad Católica del Perú, Universidad del Pacífico, Universidad Católica San Pablo, Universidad Científica del Sur and Universidad Nacional Agraria La Molina. The Universidad Científica del Sur has an 8% SRI ratio. Information Systems Research is a leading international peer-reviewed journal that focuses on the theory, research and intellectual development of information systems in organizations, institutions, economics and society.

Universidad Científica del Sur (UCSUR) is a private institution of higher education, accredited by the Peruvian Ministry of Education. Founded and recognized in 1998. It currently has 18 bachelor's and 13 master's degree programs for more than 2,000 students (The Word Universities Insights Limited, 2024).

Over the last decade, the world has been transformed by the need to find solutions to global problems, closer links between academia and industry, universities for research and the need to find more options for scientific training. Scientific knowledge has increased exponentially. New standards for the evaluation of research and the rapid dissemination of new knowledge through information technologies and the dissemination of research results in scientific journals. (Rodriguez, 2015).

Publication in leading journals is a key criterion for academic success in the competitive global higher education landscape. In addition, there is a growing need to evaluate the research results of countries and universities.

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Likewise, Orozco et al. (2017) states that the evaluation of the academic excellence of a university takes into account several indicators, one of the most decisive is scientific research, generally indexed journals. Universities need to know where they stand in relation to the rest of the world in order to develop improvement. The dissemination of the results of scientific research is fundamental for the development of science, which is why the Open Access declaration (Budapest, 2002, Bethesda, 2003, Berlin, 2003, as cited in Aguado-López et al., 2009) mentions that and the consequent efforts around "open Access" are a base that drives universities to position themselves on the Internet.

Similarly, Albornoz and Osorio (2017), mention that university rankings have recently acquired great visibility and their impact not only reaches the actors directly involved in the management of higher education, but also public opinion, through their repercussion in the journalistic media. Analyzing university rankings raises theoretical and methodological challenges that include the objectives of the rankings, the definitions of quality adopted, the units of analysis, the dimensions and indicators chosen, the sources used, the weighting criteria, the way in which the results are organized and the methods of public dissemination of the results.

Therefore, in order to propose recommendations, adjustments and/or changes in the management and administration policies of the university, this research aims to identify the scientific publications indexed in Scopus published by researchers affiliated to the Universidad Científica del Sur (UCSUR) in the area of environmental sciences, through a bibliometric review in the Scopus database.

Method

The present research is based on a bibliometric approach, which is being widely employed in different areas (Aria & Cuccurullo, 2017), consisting of five precise steps according to Zupic & Čater (2015) the first step is study design, then bibliometric data collection, followed by data analysis and finally visualization and interpretation.

Study Design

Following the review of all the information, the questions for this study were asked. The first question was: What are the publications on environmental sciences by authors affiliated to the Universidad Científica del Sur (year, subject area, type of documents and citations? It is answered by means of an Excel chart showing the evolution by year of the publications that have been made, by subject, type of document and number of citations. As a second question, what are the topics most covered by the publications made by the affiliates of the Universidad privada de lima in terms of environmental sciences? Using the bibliometric method, a graph known as a thematic map of the topics most covered by the authors and the number of publications was considered. Finally, to answer the question: What are the topics that are least covered by the publications of the affiliates of the Universidad privada de lima on environmental issues? The keywords were taken into account and using the bibliometric method in the Vosviewer software, the cooccurrence analysis was performed.

Bibliometric Data Collection

Using the Scopus database, a search was first performed by affiliation by country, university and environmental sciences. We found 200 open access documents from the years 2013 through 2024. Documents with erroneous, repeated or missing data and environmental issues were excluded, leaving 200 documents. The following algorithm was used to search for AFFILCOUNTRY (peru) AND (LIMIT-TO (SUBJAREA , "envi")) AND (LIMIT-TO (AF-ID , "universidad científica del sur" 60078122)) titles and keywords of scientific articles published in Scopus on environmental topics were included. The software used for the analysis of all documents was Excel spreadsheet, Rstudio and Vosviewe. The variables analyzed are: author, year, citations, indexed journal, language, faculty and subject.

Analysis

At this stage of the study, after uploading the data and with the objective of maintaining the viability and quality of the information, it is downloaded from Scopus in a CSV format for Microsoft Excel, Rstudio, Vosviewer and then the analysis is performed.

Visualization

In order to follow the rigorous steps of the bibliometric method, we made use of our own strategies to report the evolution by year, subject, type of document and number of citations using an Excel chart. Likewise, through the Rstudy, a thematic map of the most covered topics within the environmental sciences is made. Finally, the keywords were taken into account and a cooccurrence analysis was performed using the Vosviewer software.

Interpretation

For this research process, we proceed to answer the questions that were posed as an objective, in other words, by means of the results obtained, the final report of everything obtained about the university's publications on environmental issues is elaborated.

Results

Summary of Key Information

Table 1.
Summary of general information

Main data information	
Space of time	2013 - 2024
Articles	173
Review	14
Chapter of the book	4
Session document	4
Letter	2
Note	2
Errata	1

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Annual growth rate, %	6.5
References	11849
Keyword plus (ID)	1667
Author's keywords (DE)	812
Authors	1281
Single-authored documents	3
Co-authors per document	8.43
% of international co-authorships	66
Average citations per document	10.97

Production of Publications Per Year

Figure 1.

Publications per year, average total citations per article and per year.
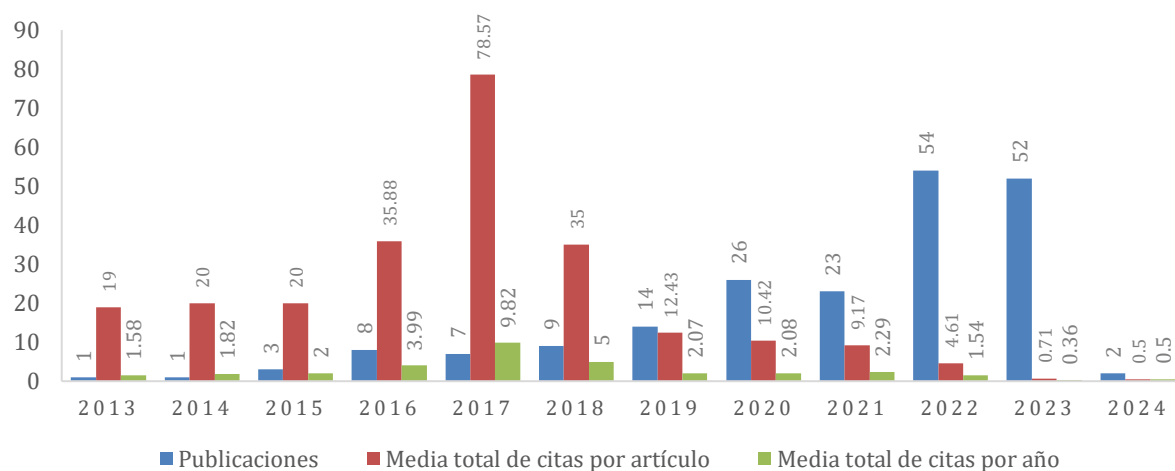
Most Relevant and High Impact Journals

Table 2.

10 journals with the most relevant sources and with the greatest local impact.

Rev. with most relevant sources	Art.	Rev. with greater local impact	H index	TC	NP	Q	Country	SJR
International journal of environmental research and public health	20	Frontiers in marine science	6	224	9	Q1	Switzerland	1.12
Frontiers in marine science	9	Biological conservation	4	139	5	Q1	Countries Low	2.15

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Marine pollution bulletin	8	International journal of environmental research and public health	4	59	20	Q2	Switzerland	0.83
Sustainability (switzerland)	7	Marine pollution bulletin	4	41	8	Q1	Reino United	1.49
Biological conservation	5	Sustainability (switzerland)	4	79	7	Q1	Switzerland	0.66
Marine and Coastal Research Bulletin	4	Endangered species research	3	109	4	Q1	Germany	0.94
Endangered species research	4	Marine ecology progress series	3	88	4	Q1	Germany	0.86
farm	4	Aquatic mammals	2	14	2	Q2	Countries Low	0.39
Journal of law and sustainable development	4	Carbon management	2	19	2	Q2	Reino United	0.64
Marine ecology progress series	4	Conservation science and practice	2	18	2	Q1	United States	0.98

Note: TC = total number of citations / NP = number of publications /

Table 3.

10 most relevant authors with the greatest local impact.

Most relevant authors	Art.	Fractional items	Authors with local impact	index_h	TC
Alfaro-Shigueto J	37	5.48	Alfaro-Shigueto J.	13	526
Mangel JC.	34	4.76	Mangel J.	12	506
Ladd B.	21	4.11	Ladd B.	11	261
Iannacone J.	15	4.4	Godley BJ.	8	322
Hernández-Vásquez A.	12	3.72	Peri Pl.	7	151
Godley BJ.	10	1.21	Amelung W.	5	84
Peri Pl.	10	1.6	Borchard N.	5	111
Aponte H.	9	2.22	Duarte-Guardia S.	5	74

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| Bendezu-Quispe G. | 9 | 1.73 | Moreno B. | 5 | 549 |
| Campbell E. | 8 | 0.87 | Aponte H. | 4 | 77 |

Note: Art: Articles

Table 4.

10 articles with the greatest impact.

Title of the paper	Authors	Quotations totals	CT year	CT norm.
Microplastics in the Antarctic marine system: An emerging area of research	Waller et al. (2017)	480	60	6.11
Main drivers of changes in CO2 emissions in the Spanish economy: A structural decomposition analysis	Cansino, Román & Ordóñez (2016)	163	18.11	4.54
Impacts of Marine Plastic Pollution from Continental Coasts to Subtropical Gyres-Fish, Seabirds, and Other Vertebrates in the SE Pacific	Thiel et al. (2018)	150	21.43	4.29
Binational survey of personal protective equipment (PPE) pollution driven by the COVID-19 pandemic in coastal environments: Abundance, distribution, and analytical characterization	De-la-Torre et al. (2022)	77	25.67	16.7
Reducing green turtle bycatch in small-scale fisheries using illuminated gillnets: the cost of saving a sea turtle	Ortiz et al. (2016)	65	7.22	1.81
Marine mammal conservation: over the horizon	Nelms et al. (2021)	63	15.75	6.87
Remote electronic monitoring as a potential alternative to on-board observers in small-scale fisheries	Bartholomew et al. (2018)	62	8.86	1.77
An illuminating idea to reduce bycatch in the Peruvian small-scale gillnet fishery	Bielli et al. (2020)	55	11	5.28
Charting the course for a blue economy in Peru: a research agenda	McKinley et al. (2019)	43	7.17	3.46

Testing a global standard for quantifying species recovery and assessing conservation impact	Grace et al. (2021)	42	10.5	4.58

Note: CT year = appointments per year / CT norm. = standardized quotations.

Figure 2.

Bibliometric map by authors and citations
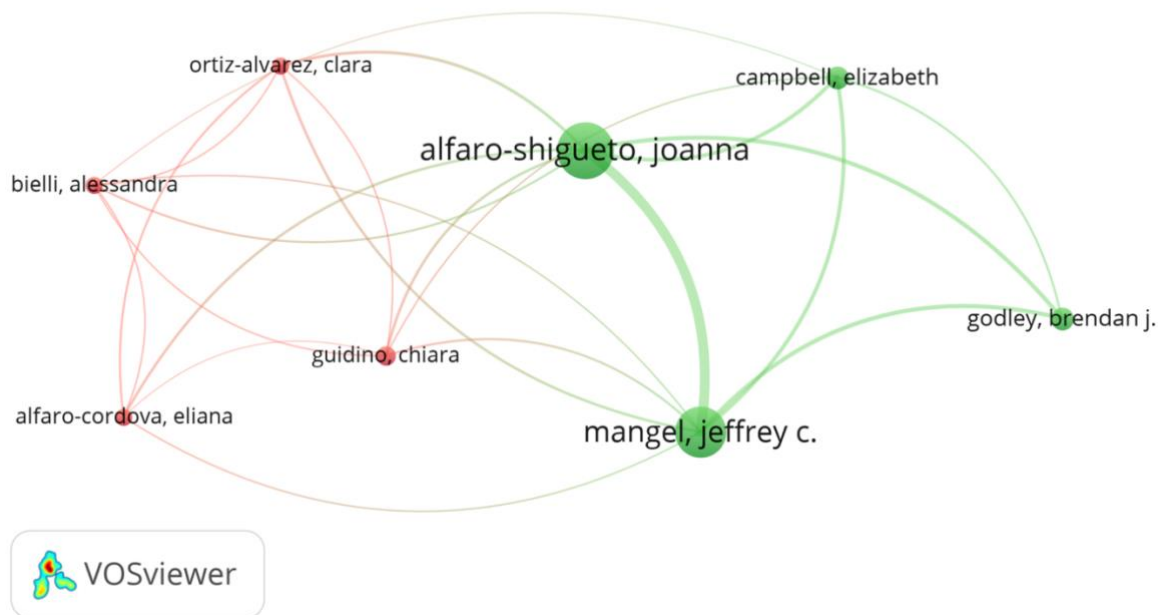
Figure 3.

Bibliometric map by keywords of environmental sciences.
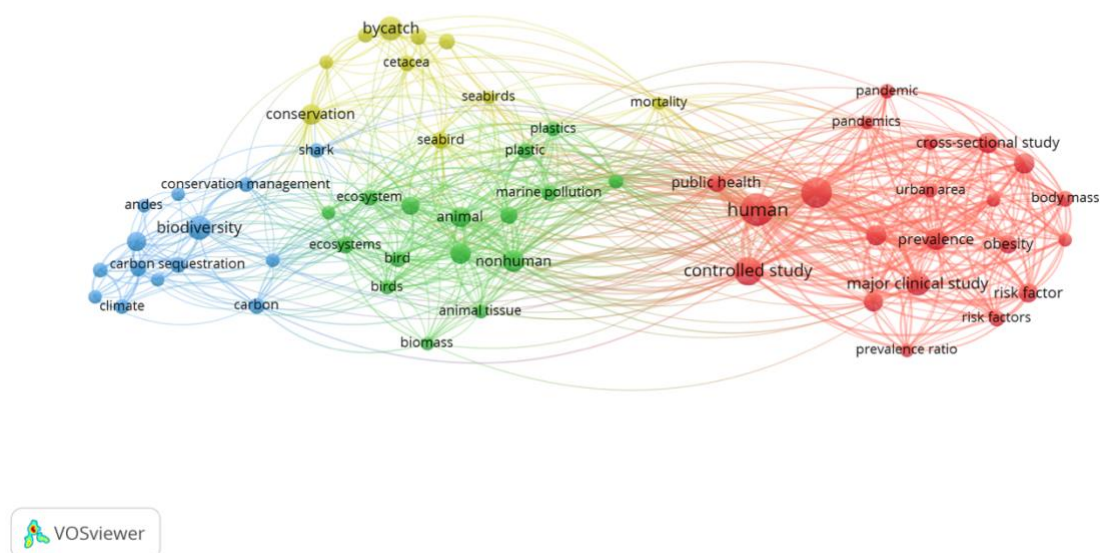
Discussion and Conclusions

Table 1 presents the summary of publications in Scopus on environmental issues, in the years 2013 to 2024 and the total number of documents are 200 of which mostly are articles (173) and then review (14) and the annual growth is 6.5, the number of authors are 1281 and they managed to cite 11849 in their references (average of 10.97 per document), a total of 1667 keywords and co-authorship is 8.43.

Figure 1 shows that document publications by year from 2013 to 2024 have had an annual increase of 6.5%. The university has started publishing since 2013 and the significant increase has been in 2019 with 14 documents, for the following year 2020 it increased by 12 making a total of 26. However, in 2021, production decreased to 23 publications. By 2022, the authors reached 54 papers and by the following year they only reached 52, it is expected that by 2024 they will have the same results.

Regarding the average total citations per article, it is observed that since the beginning of the publications which was in 2013 until 2024 the growth has been progressive from 19 in 2013, 35.88 in 2016 and there was a rise of 78.57 in 2017 being this the year with more citations per article, despite the fact that that year there were only 7 publications. In 2018 the citations decrease to 35 and so it has been decreasing until 2023 that only 0.71 were cited.

For the average total number of appointments per year, it is observed that in 2013 it starts with 1.58 having a progressive growth until 2017 with 9.82 being this the year with more appointments. However, 2018 decreases to 5 and 2017 quotes remain between 2.07 to 2.29 in 2021, but by 2022 they decrease to 1.54 and 2023 to 0.36.

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In Table 2. The analysis of the extracted documents shows a ranking of the 10 journals with the most relevant sources, of which "International journal of environmental research and public health" stands out with 20 articles, followed by "Frontiers in marine science" with only 9 documents and the last on the list is "Marine ecology progress series" with 4 undecided products.

In reference to the 10 journals with the highest local impact, "Frontiers in marine science" tops the list with a 6 H index and a total number of citations of 224, followed by 4 journals with the same scores (4) "Biological conservation" with TC=139, "International journal of environmental research and public health", "Marine pollution bulletin" and "Sustainability (switzerland)". It is observed that the journal "Endangered species research" has a total number of citations of 109, but with less local impact and "Conservation science and practice" is the journal with less local impact in the list with 2 documents and a TC=18.

Similarly, the journal with the highest number of publications is "International journal of environmental research and public health" from Switzerland with a Q2 and an SJR=0.83. However, it does not have much local impact; it is third on the list. The countries in which they are published are Switzerland, the Netherlands, the United Kingdom, Germany and the USA. The impact level is between Q1 and Q2 with SJR = 0.39 to 2.15.

Table 3 presents the list of the 10 most relevant authors from which it is observed that Alfaro-Shigueto occupies the first place with the highest production of 37 publications between the years 2013 to 2024, followed by Mangel JC with 34 publications and Ladd B with 15 and the last in the list with 8 articles is Campbell E.

The 10 authors with the highest local impact are Alfaro-Shigueto with an index_h of 13 total citations 526, followed by Mangel J with an index-H of 12 and a TC = 506, Ladd B with an index_h of 11 and TC=261, the last in the list is Aponte H. with an index_h of 4 and total citations of 77.

When an analysis of the total number of citations is made, Moreno B has the highest impact 549 with an H-index of 5, this is due to the fact that the published topic has attracted the attention of other authors and that is why he has been cited, followed by Alfaro-Shigueto J. with 526 and an H-index of 13, then Mangel with 506 and an index of 12. Last on the list is Duarte-Guardia S. with an h-index of 5 and 74 total citations.

In the ranking of the 10 articles with the greatest impact, the one that stands out is "Microplastics in the Antarctic marine system: An emerging area of research" by Waller, C., Griffiths, H., Waluda, C., Thorpe, S., Loaiza, I., Moreno, B., Pacherres, C., & Hughes, K. published in 2017(Waller et al., 2017) has come to be cited by 480 studies, which ranks second is the 2016 article entitled "Main drivers of changes in CO2 emissions in the Spanish economy: A structural decomposition analysis" by authors Cansino, J. M., Román, R., & Ordóñez, M. (Cansino et al., 2015) which has had an impact on 163 studies and is followed by the work of Thiel, M., Luna-Jorquera, G., Álvarez-Varas, R., Gallardo, C., Hinojosa, I. A., Luna, N., Miranda-Urbina, D., Morales, N., Ory, N., Pacheco, A. S., Portflitt-Toro, M., & Zavalaga, C. from 2018 on "Impacts of Marine Plastic Pollution from Continental Coasts to Subtropical Gyres-Fish, Seabirds, and Other Vertebrates in the SE Pacific" (Thiel et al., 2018) with total citations of 150.

Another study that has had an impact with 77 times cited was "Binational survey of personal protective equipment (PPE) pollution driven by the COVID-19 pandemic in coastal environments: Abundance, distribution, and analytical characterization" by authors De-la-Torre, G. E., Dioses-Salinas, D. C., Pizarro-Ortega, C. I., Fernández Severini, M. D., Forero López, A. D., Mansilla, R., Ayala, F., Castillo, L. M. J., Castillo-Paico, E., Torres, D. A., Mendoza-Castilla, L. M., Meza-Chuquizuta, C., Vizcarra, J. K., Mejía, M., De La Gala, J. J.

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V., Ninaja, E. A. S., Calisaya, D. L. S., Flores-Miranda, W. E., Rosillo, J. L. E., ... Santillán, L. of the year 2022 (De-la-Torre et al., 2022). The last on the list is the article entitled "Testing a global standard for quantifying species recovery and assessing conservation impact" by authors Grace, M. K., Akçakaya, H. R., Bennett, E. L., Brooks, T. M., Heath, A., Hedges, S., Hilton-Taylor, C., Hoffmann, M., Hochkirch, A., Jenkins, R., Keith, D. A., Long, B., Mallon, D. P., Meijaard, E., Milner-Gulland, E. J., Rodriguez, J. P., Stephenson, P. J., Stuart, S. N., Young, R. P., ... Young, S. published in 2021 has come to be cited in total by 42 publications (Grace et al. 2021).

Figure 2 shows a map of authors and the first red cluster shows that Alfaro-Cordova, Eliana has published with Alessandra Bielli, Chiara Guidino and Ortiz-Alvarez, Clara. In Alfaro-Shigueto green cluster 2, Joanna has the most publications with Elizabeth Campbell, followed by Brendan J. Godley and Jeffrey C. Mangel.

The relationship between the keywords is presented in graph 2, in which it is observed that cluster 1, which is red, has 21 items of which the most worked are body mass, body mass index, controlled study, cross-sectional, epidemiology, health survey, human, etc. In cluster 2 of green color there are 16 items and the key words are animals, animal tissue, biomass, bird, ecosystem, environmental monitoring, fish, environmental pollution, etc. In cluster 3 of blue color there are 14 items that covered about words: andes, biodiversity, carbon sequestration, climate, climate change, conservation management, etc. Finally, in cluster 4 in yellow, there are 10 items on the words bycatch, cetaceans, conservation, dolphins, gillnets, mortality, etc.

Conclusions:

UCSUR's scientific production shows a growth trend, achieving 200 publications from 2013 to 2024. The years 2022 and 2023 were the years with the highest number of publications 54 and 52 respectively. The year 2017 reports the highest total mean number of citations per article (78.57).

The journal with the most publications is "Marine pollution bulletin" from Switzerland with a Q2, SJR = 0.83, with 20 articles. However, it does not have much local impact, it is third on the list (TC=59). The journal with the highest local impact is "International journal of environmental research and public health" with 6 H index, Q, SJR= 1.12 and with a total number of citations of 224.

In the 200 publications, 1281 authors were found, of which 161 are affiliated to UCSUR. The most relevant authors are: Alfaro-Shigueto ranks first with 37 publications, index_h of 13 total citations 526, Mangel JC with 34 publications, with an index-H of 12 and a TC = 506, and Ladd B with 15, with an index_h of 11 and TC=261. Similarly, E. Moreno B. with an index h 5 is the author with the most citations, 549. Two groups of authors have been identified. The first, with more publications, is composed of Alfaro-Shigueto, Manguel, Campbell and Godley; the second, with fewer publications, is composed of Ortiz, Bielli, Alfaro-Córdova and Guidino.

In terms of keywords, the four clusters identified show words that are not normally associated with the field of environmental sciences such as human, clinical study, and non-human. While, in the less relevant clusters, words associated with the field of environmental sciences can be found such as: conservation, ecosystem and pollution. This situation is in agreement with those mentioned by Morales-Jasso et al. (2022) who says that environmental sciences combine different disciplines to generate comprehensive knowledge.

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The article with the highest impact is "Microplastics in the Antarctic marine system: An emerging area of research" by Waller, C., Griffiths, H., Waluda, C., Thorpe, S., Loaiza, I., Moreno, B., Pacherres, C., & Hughes, K. published in 2017 (Waller et al., 2017) has gone on to be cited by 480 publications.

The countries in which they are published are Switzerland, the Netherlands, the United Kingdom, Germany and the USA. The impact level is between Q1 and Q2 with SJR = 0.39 to 2.15.

Limitations:

The present research only includes the Scopus database.

Only publications since 2013 have been included.

The area of environmental sciences is too broad a term to serve as a reference for certain types of research.

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PROJECT-BASED LEARNING AND COMPETENCY DEVELOPMENT IN SOCIAL SCIENCES AT THE SECONDARY EDUCATION LEVEL: AN ANALYSIS OF THE COLOMBIAN CONTEXT

Aprendizaje basado en proyectos y desarrollo de competencias en ciencias sociales en el nivel de la básica secundaria: un análisis del contexto colombiano

Luis Alberto Pérez Sáenz
Universidad del Atlántico, Colombia (academico1889@gmail.com)(https://orcid.org/0009-0002-4922-8260)

	ABSTRACT
	This systematic review examines the effectiveness of Project-Based Learning (PBL) in developing social science competencies in secondary education, with emphasis on the Colombian context and the competencies assessed by Colombian Institute for the Promotion of Higher Education (ICFES). Studies published between 2009 and 2024 addressing PBL in social science teaching were analyzed, focusing on competency development and its application in secondary education. Participants in the reviewed studies primarily include secondary students and their teachers. Evidence suggests that PBL is effective in developing critical thinking skills and historical analysis abilities. However, a significant gap was identified in specific research on the development of competencies evaluated by ICFES in the Colombian context. Limitations include the scarcity of longitudinal studies and lack of uniformity in competency measurement. The review concludes that there is an urgent need for contextualized research on the application of PBL to develop specific social science competencies assessed in Colombia. It is necessary to adapt PBL to the Colombian educational context, develop assessment instruments aligned with ICFES competencies, and conduct longitudinal studies to evaluate its long-term effectiveness.
	RESUMEN
	Esta revisión sistemática examina la efectividad del Aprendizaje Basado en Proyectos (ABP) en el desarrollo de competencias en ciencias sociales en la educación básica secundaria, con énfasis en el contexto colombiano y las competencias evaluadas por el Instituto Colombiano para el Fomento de la Educación Superior (ICFES). Se analizaron estudios publicados entre 2009 y 2024 que abordan el ABP en la enseñanza de ciencias sociales, centrándose en el desarrollo de competencias y su aplicación en educación secundaria. Los participantes en los estudios revisados incluyen principalmente estudiantes de secundaria y sus docentes. La evidencia sugiere que el ABP es efectivo para desarrollar habilidades de pensamiento crítico y análisis histórico. Sin embargo, se identificó una brecha significativa en la investigación específica sobre el

desarrollo de las competencias evaluadas por el ICFES en el contexto colombiano. Las limitaciones incluyen la escasez de estudios longitudinales y la falta de uniformidad en la medición de competencias. Se concluye que existe una necesidad urgente de investigación contextualizada sobre la aplicación del ABP para desarrollar las competencias específicas en ciencias sociales evaluadas en Colombia. Se requiere adaptar el ABP al contexto educativo colombiano, desarrollar instrumentos de evaluación alineados con las competencias del ICFES y realizar estudios longitudinales para evaluar su efectividad a largo plazo.

Introduction

Project Based Learning (PBL) has established itself as a fundamental educational methodology for the development of 21st century skills. This methodology engages students in a deep investigation of complex and authentic problems, allowing them to work more autonomously to construct their own learning. As a result, more meaningful and lasting knowledge is obtained, improving not only information retention, but also developing critical skills such as problem solving and critical thinking (Thomas, 2000).

Kokotsaki et al. (2016) emphasize that PBL fosters student autonomy, improves their problem-solving skills and promotes critical thinking. By facing real-world challenges, students not only acquire deeper knowledge, but also develop essential skills for their professional and personal future.

The advantages of PBL are multiple and significant. Blank (1997) and Dickinson et al. (1998) note that students develop essential skills and competencies such as collaboration, project planning, communication, decision making and time management. These skills are critical to success in the world of work and in everyday life, making PBL a highly valuable educational strategy.

Chen and Yang (2019) note that PBL significantly improves long-term knowledge retention and the ability to apply what has been learned in new situations. In addition, these researchers emphasize that PBL promotes collaborative and communication skills, preparing students for increasingly collaborative and globalized work environments.

The competency-based learning approach emerged in the 1970s as a response to the need to link education with the demands of the labor and social world (Mulder et al., 2007). This approach has spread globally, influencing educational policies in many countries, including Colombia. In the Colombian context, the Ministry of National Education (MEN) has adopted this approach to align the educational system with international standards and local needs, seeking to train citizens capable of applying their knowledge in real and complex situations.

In the specific field of social sciences, the Colombian Institute for the Promotion of Higher Education (ICFES) has established three fundamental competencies that permeate the curriculum and are subject to assessment: social thinking, interpretation and analysis of perspectives, and reflective and systemic thinking (ICFES, 2019). These competencies seek to develop in students the ability to understand and analyze social phenomena from multiple perspectives, foster critical thinking and promote a holistic understanding of social reality. The MEN has integrated these competencies into the curricular standards, with the objective of forming citizens capable of understanding and actively participating in Colombian society.

Social thinking focuses on understanding social reality; interpretation and analysis of perspectives seeks to develop the ability to examine and contrast different points of view; while reflective and systemic thinking promotes the understanding of the interrelationships between social phenomena (ICFES, 2019). These competencies are not only evaluated by the ICFES in standardized tests, but also guide curriculum planning and pedagogical practices in Colombian classrooms. The fundamental objective of these competencies is to train critical, reflective citizens capable of contributing positively to society, addressing the country's social, political and economic challenges from an informed and analytical perspective.

In this context, the need arises to examine how Project Based Learning (PBL) can contribute to the development of these specific competencies in social sciences in the field

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of basic secondary education in Colombia. Therefore, the central question guiding this literature review is: What are the most common pedagogical uses of Project Based Learning in scientific publications related to the development of competencies in social sciences at the secondary school level in the Colombian context?

To address this question, the present literature review proposes the following objectives:

1. To investigate the current state of research in social sciences using PBL to develop competencies at the secondary school level, with a particular focus on the Colombian context.
2. To examine to what extent existing research on PBL in social science teaching is aimed at developing the specific competencies assessed by the ICFES: social thinking, interpretation and analysis of perspectives, and reflective and systemic thinking.
3. Analyze how the PBL approach has been addressed in the field of social science education, identifying the main trends and predominant areas of focus.
4. To evaluate the need and potential of adopting the PBL model to strengthen or develop specific competencies in social sciences in the Colombian educational context.
5. Propose future lines of research that can contribute to the effective adaptation of PBL for the development of the competencies evaluated by the ICFES in the area of social sciences.

With these objectives in mind, it is crucial to examine the available evidence on the application of PBL in social science teaching and its potential to develop the specific competencies assessed by the ICFES. Several studies have explored the effectiveness of PBL in different aspects of social studies teaching.

In the field of education, Project Based Learning (PBL) has proven to be an innovative and effective methodological strategy, especially in the teaching of social sciences. The research by Cárdenas-Contreras et al. (2020) showed that PBL not only fosters more meaningful learning by linking content to real-life situations, but also promotes students' active participation and enhances their understanding of social phenomena, allowing them to explore issues from multiple perspectives.

For their part, Martínez Camarena and Colomer Rubio (2019) explored the potential of PBL for the development of historical thinking competencies in Compulsory Secondary Education. Their findings suggest that PBL facilitates students' construction of historical narratives and enhances their ability to interpret and analyze historical sources, thus fostering a more critical and analytical approach to historical events.

Fernández Naranjo (2016) addressed the application of PBL in the teaching of social sciences, highlighting its potential to integrate different disciplines. Their research indicates that PBL enables students to make connections between history, geography and economics, fostering more holistic and systems thinking.

In a more recent study, Obando-Arias (2021) explored the pedagogical mediation of learning based on the generative question in secondary education, using PBL. The results of their research suggest that the use of generative questions in social science projects stimulates critical thinking, improves students' ability to tackle complex problems, and fosters autonomy and self-regulation in learning.

Corica (2021) conducted an exploratory study on the experience of in-service teachers with PBL in Argentine secondary schools. Their results highlight that teachers recognize the potential of PBL to develop transversal competencies, but also identify

significant challenges in its implementation, especially in terms of planning and evaluation.

Following this line, Urrea-Polo (2022) investigated the influence of PBL in the teaching-learning of history. Their results indicate that PBL significantly improves retention of historical knowledge, develops critical thinking skills and analysis of historical sources, and increases students' motivation and engagement in learning history.

Pimenta and Calderón (2023) conducted a literature review on PBL as a facilitator of school success. Their findings suggest that PBL is especially effective in the social sciences and humanities, improving not only academic performance but also critical thinking and problem-solving skills.

With respect to academics, Gómez and Miralles (2015) point out that the teaching of history, as a crucial component of the social sciences, must transcend memorization and focus on the development of historical thinking. This approach aligns with the competencies assessed by ICFES, but raises the question of how PBL can facilitate this development in an effective and measurable way in the Colombian context.

Mergendoller and Maxwell (2016) provide a solid foundation for the effective implementation of Project-Based Learning (PBL) in the classroom, highlighting the crucial importance of meticulous planning and structured execution to maximize the benefits of this innovative methodology. These authors emphasize that successful PBL is not a matter of chance, but the result of careful design and skillful management by the teacher. Its principles emphasize the need to set clear objectives, create a conducive learning environment and facilitate collaboration among students.

In line with this perspective, Martínez-Rodríguez and Sánchez-Agustí (2018) broaden the scope of the discussion by emphasizing the vital importance of contextualizing educational research. This approach underscores the imperative need to thoroughly examine the applicability of PBL in the Colombian curricular framework, considering the cultural, social and educational particularities of the country. The authors argue that this contextualization is fundamental to ensure that the implementation of PBL is not only effective, but also responds to the specific needs of the Colombian educational system and its potential to develop essential social and civic competencies in the national context.

Complementing these ideas, Larmer et al. (2015) set rigorous standards for PBL, providing a methodical and systematic approach to classroom instruction. These standards offer a robust framework that could be adapted and customized to the specific context of social sciences in Colombia. The authors detail key elements such as challenge or guiding question, sustained inquiry, authenticity, student voice and choice, reflection, critique and revision, and public product, all of which could significantly enrich social science teaching in the Colombian context.

Integrating the technological dimension to this discussion, Hernández-Ramos and De La Paz (2009) innovatively explored the learning of history in high school through multimedia design in a PBL experience. Their research highlights the enormous potential of technology to substantially improve student engagement and understanding in the social sciences. This approach not only makes learning more engaging and relevant to 21st century learners, but also fosters the development of crucial digital skills in the information age.

Finally, Brush and Saye (2014) propose a sophisticated and well-structured instructional model to support problem-based historical research. This model could be particularly relevant and applicable to the development of the specific competencies

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assessed by the ICFES in social sciences in Colombia. The authors present an approach that combines historical thinking with problem solving, which is closely aligned with the Colombian educational objectives of forming critical and analytical citizens.

Finally, Summers and Dickinson (2012) conducted longitudinal research on project-based instruction and student achievement in high school social studies, providing long-term evidence of the benefits of PBL in this field.

Taken together, these authors offer a multifaceted and complementary perspective on the implementation of PBL in social science teaching. Their contributions, from effective classroom management to technology integration to the development of specific models for historical research, provide a robust theoretical and practical framework. This framework can be adapted and applied to the Colombian educational context, thus enhancing the development of crucial competencies in social sciences and preparing students for the challenges of the contemporary world.

It also highlights the relevance and effectiveness of PBL as a methodology that not only enriches the educational experience in the social sciences, but also prepares students to face the challenges of the real world with a critical and analytical approach.

This introduction has established the central issues surrounding the application of Project Based Learning (PBL) for the development of specific competencies in social sciences in the context of basic secondary education in Colombia. Clear objectives have been outlined to guide the literature review, focused on examining the current state of research, analyzing existing trends and evaluating the potential of PBA in the Colombian context.

The review of the available evidence has revealed a significant body of research on PBL in social science teaching, but it has also revealed a need for specific application to develop the competencies assessed by the ICFES in Colombia. Aspects that will be discussed in depth in the results of this review.

In summary, this literature review seeks to explore the intersection between Project Based Learning and the development of specific competencies in social sciences in the Colombian context of junior high school. Through an exhaustive analysis of the existing literature, the aim is to identify the most effective PBL practices in the teaching of social sciences and to examine their potential for developing the competencies assessed by the ICFES. This study seeks to contribute to the educational field by providing a solid foundation for future research and pedagogical practices that effectively integrate PBL with the development of social science competencies in Colombia. The results of this review could inform educational policies and teaching practices, promoting a more effective and contextualized teaching of social sciences in Colombian secondary education.

Method

This research is based on a systematic and analytical literature review on Project Based Learning (PBL) as a methodological strategy for teaching Social Sciences in the context of secondary education, with emphasis on the development of competencies assessed by the ICFES in Colombia.

Sources of information and search period: The following databases and specialized information sources were used: Scielo, Google Schoolar, Dialnet, ERIC, Redalyc and university institutional repositories. In addition, journals specialized in education and

social science didactics were consulted. The search period covered publications from 2009 to 2024, to ensure the inclusion of recent and relevant research in the field.

The search strategy used keywords and combinations in Spanish and English: "Project-Based Learning" AND "Social Sciences", "PBL" AND "secondary education", "Project-Based Learning" AND "Social Sciences", "social sciences competencies" AND "Colombia", "PBL" AND "historical thinking", "active methodologies" AND "social sciences", "PBL" AND "history education"

The inclusion criteria included articles and studies published in specialized academic sources, research specifically addressing PBL in the teaching of social sciences, studies relating PBL to the development of competencies in social sciences, publications contextualizing PBL in the Colombian educational system or in similar contexts, and research providing empirical evidence on the effectiveness of PBL in social sciences.

In turn, for exclusion criteria, opinion articles or editorials with no empirical basis, studies that do not focus specifically on social sciences or secondary education, publications that do not address PBL as a main methodology, and research that does not provide relevant information on competencies or learning outcomes.

These criteria were established to ensure the relevance and quality of the sources included in the review. Empirical studies and systematic reviews were prioritized to ensure a solid evidence base. The inclusion of contextualized research in Colombia or similar educational systems seeks to ensure the applicability of the findings to the specific context of the study.

The review process began with a total of 41 articles and studies initially identified. After an initial review of titles and abstracts, 12 articles were excluded for not meeting the inclusion criteria, mainly because they did not focus specifically on PBL in the social sciences or were not relevant to the secondary education context.

In a second review phase, the full texts of the remaining 29 articles were analyzed. Five more were excluded: 2 for lack of solid empirical evidence, 2 for not explicitly addressing social science competencies, and 1 for focusing on an educational context that is not comparable to the Colombian context.

Finally, 24 articles were selected for inclusion in the final review. These articles met all inclusion criteria and provided relevant and quality information to address the research objectives.

The content analysis technique was used to analyze the selected articles. An Excel matrix was designed to organize and categorize the information extracted from each article. The main categories of analysis included: characteristics of PBL implemented, social science competencies developed, assessment methodologies used, results and effectiveness of PBL, challenges and limitations in implementation, and recommendations for educational practice. This matrix allowed for a systematic synthesis of the information and facilitated the identification of patterns, trends and key findings across the different studies.

the text is in 12-point Cambria font, single-spaced and with no spacing between paragraphs.

Results

The analysis of the 24 selected articles on Project Based Learning (PBL) in the teaching of social sciences reveals significant findings in relation to the development of competencies in basic secondary education, with particular attention to the

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Colombian context. The results are presented organized according to nine established categories of analysis, addressing the research objectives and responding to the problem posed.

1. Characteristics of PBL implemented in social sciences

The studies analyzed show a diversity of approaches in the implementation of PBL in the social sciences, although some common trends can be observed.

Mergendoller and Maxwell (2016) provide a solid foundation for effective PBL implementation, highlighting the importance of meticulous planning and structured execution. His study, based on the experience of 12 secondary school teachers, emphasizes that successful PBL is not a matter of chance, but the result of careful design and skillful management by the teacher. The authors identify key principles as setting clear objectives, creating a conducive learning environment, and facilitating collaboration among students.

Larmer et al. (2015) set rigorous standards for PBL, providing a systematic approach to classroom instruction. His book, based on an extensive review of literature and practice, details essential elements such as the challenge or guiding question, sustained inquiry, authenticity, student voice and choice, reflection, critique and revision, and public product. These standards have been adopted and adapted in several of the subsequent studies analyzed, suggesting a convergence towards a more structured model of PBL in the social sciences.

The integration of technology in PBL projects is emerging as a significant trend. Hernandez-Ramos and De La Paz (2009) explored the learning of history in high school through multimedia design. Their study, which involved 100 eighth-grade students, demonstrated how creating multimedia presentations about historical events significantly improved students' historical understanding and writing skills compared to a control group.

2. Social science competencies developed

In relation to the competencies assessed by the ICFES, the studies show an uneven approach:

Social thinking: This competence emerges as the one most addressed in the studies analyzed. Brush and Saye (2014) propose an instructional model to support problem-based historical inquiry. Their study, which involved 15 high school history teachers and their students, demonstrated how this approach significantly improved students' ability to analyze historical events from multiple perspectives and understand connections between the past and present.

Gómez and Miralles (2015) examined the assessment of historical content in compulsory education in Spain. Although his study does not focus specifically on PBL, it provides valuable input on how to assess historical thinking, which is a key component of social thinking. The authors argue that assessments should go beyond memorization of facts and dates, and focus on skills such as historical contextualization and use of primary sources.

Interpretation and analysis of perspectives: Martínez-Rodríguez and Sánchez-Agustí (2018) emphasize the importance of contextualizing educational research. Their study, based on a review of 50 articles on history teaching, highlights the need to examine the applicability of PBL in different educational contexts. The authors argue that PBL can be particularly effective in developing students' ability to interpret historical events from multiple perspectives.

Reflective and systemic thinking: This competence appears as the least explicitly studied in the articles reviewed. However, Summers and Dickinson (2012)

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conducted longitudinal research on project-based instruction and student achievement in high school social studies. Their study, which followed 114 students for three years, found that PBL fostered more holistic and reflective thinking about social and historical systems compared to traditional teaching methods.

3. Evaluation methodologies used

The studies reviewed employ a variety of methods to evaluate the effectiveness of PBA:

Cárdenas-Contreras et al. (2020) used a mixed approach in their study on PBL as a methodological strategy for teaching social sciences in high school. They used pre- and post-intervention questionnaires to measure change in students' knowledge and skills, supplemented by interviews with teachers and students to obtain qualitative findings about the learning experience.

Martínez Camarena and Colomer Rubio (2019) adopted a qualitative approach in their study on the development of historical thinking competencies through PBL. They used classroom observations, analysis of student products, and interviews to assess how the projects contributed to the development of skills such as historical contextualization and the use of primary sources.

Urrea-Polo (2022) employed a quasi-experimental design in his study on the influence of PBL in the teaching-learning of history. It used an experimental group and a control group, applying standardized tests before and after the intervention to measure the impact of PBA on academic performance and historical thinking skills.

4. Results and effectiveness of PBA

Most studies report positive results in terms of motivation, student engagement and development of specific competencies in social sciences.

Obando-Arias (2021) found that the use of generative questions in the context of PBL significantly improved student engagement and critical thinking in social science courses. Their study, which involved 60 middle school students, demonstrated how PBL can foster deeper and more meaningful learning.

Corica (2021), in his exploratory study on the experience of secondary school teachers with PBL in Argentina, found that teachers perceived an improvement in students' research and analysis skills. However, he also identified challenges in implementation, such as lack of time and resources.

De la Torre Neches (2021) conducted a case study on the potential of PBL as a teaching-learning model in secondary education, focusing on the subject of Economics. Their results suggest that PBL is particularly effective in developing critical thinking and problem-solving skills in the context of the social sciences.

5. Implementation challenges and constraints

The studies identify several common challenges in implementing PBA:

Time and resources: Several studies, including that of Espinosa Atero (2021), point to the need for additional time for project planning and execution, as well as adequate technological and material resources.

Teacher professional development: Fernández Naranjo (2016) emphasizes the importance of teacher training to effectively implement PBL in social science classes.

Evaluation: Gómez and Miralles (2015) highlight the difficulty of assessing complex competencies developed through PBL, suggesting the need for new assessment tools.

6. Colombian context and applicability

Although specific research in the Colombian context is limited, some studies provide relevant contributions:

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Cárdenas-Contreras et al. (2020) demonstrate the viability and effectiveness of PBL in the development of citizenship competencies in the Colombian high school. Their study, conducted in an educational institution in Ecuador, but with implications for the Latin American context, suggests that PBL can be an effective strategy to address the competencies assessed by the ICFES.

Urrea-Polo (2022) points out the need to adapt PBA to the socioeconomic realities of Colombian schools. Their study, although focused on the teaching of history, provides important insights on how PBL can be effectively implemented in the Colombian educational context.

7. Critical evaluation of the reviewed studies

In this category, strengths and weaknesses were analyzed as determining factors in the evaluation of these studies.

strengths:

- Methodological rigor: Studies such as Summers and Dickinson (2012) and Hernandez-Ramos and De La Paz (2009) employ robust designs, including control groups and longitudinal measurements.
- Diversity of contexts: The studies cover diverse educational contexts, from Spain (Gómez and Miralles, 2015) to Argentina (Corica, 2021) and Colombia (Urrea-Polo, 2022), providing a broad view of the applicability of PBL.
- Focus on specific competencies: Several studies, such as Brush and Saye (2014), focus explicitly on the development of key competencies in social sciences.

Weaknesses:

- Shortage of longitudinal studies: With exceptions such as Summers and Dickinson (2012), few studies evaluate the long-term impact of PBA.
- Limited research in the Colombian context: Although studies such as that of Cárdenas-Contreras et al. (2020) and Urrea-Polo (2022) address the Latin American context, there is a need for more research specific to Colombia.
- Lack of uniformity in the measurement of competencies: The diversity of approaches to assessing social science competencies makes direct comparisons between studies difficult.

8. Similarities, contradictions and relationships between the articles reviewed

Similarities:

- Focus on historical thinking: Several studies, including Brush and Saye (2014), Gómez and Miralles (2015), and Martínez Camarena and Colomer Rubio (2019), emphasize the importance of PBL for developing historical thinking skills.
- Importance of authenticity: Studies such as that of Larmer et al. (2015) and Obando-Arias (2021) stress the need for authentic and relevant projects for students.
- Implementation challenges: Most studies, including Corica (2021) and Espinosa Atero (2021), identify similar challenges in terms of time, resources and teacher training.

Contradictions:

- Structure level: While studies such as Mergendoller and Maxwell (2016) advocate a highly structured approach to PBL, others such as De la Torre Neches (2021) suggest a more flexible approach.

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- Effectiveness compared to traditional methods: Although most studies report positive results from PBA, there are variations in the magnitude of impact compared to traditional methods.

Relationships:

- Time progression: There has been an evolution in the PBL approach, from more general studies such as that of Hernández-Ramos and De La Paz (2009) to more specific and contextualized research such as that of Urrea-Polo (2022).
- Complementarity: Theoretical studies such as that of Larmer et al. (2015) provide a framework that is tested and refined in subsequent empirical studies.

9. Implications for the Colombian context

The findings suggest that PBL has a significant potential to develop the competencies assessed by the ICFES in social sciences in the Colombian context. However, several areas are identified as requiring attention:

Contextual adaptation: As Urrea-Polo (2022) points out, it is crucial to adapt PBL to the socioeconomic and cultural realities of Colombian schools.

Teacher training: Studies such as that of Fernández Naranjo (2016) underscore the need for specific professional development to effectively implement PBL in social sciences.

Evaluation: Following the reflections of Gómez and Miralles (2015), it is necessary to develop assessment instruments that are aligned with the specific competencies assessed by the ICFES and that are compatible with the PBL approach.

Technological integration: Research by Hernández-Ramos and De La Paz (2009) suggests that the integration of technology in PBL projects can be particularly beneficial, but this requires careful consideration of the technological capabilities of Colombian schools.

In conclusion, this review reveals a promising outlook for the implementation of PBL in social science teaching in Colombia, with evidence of its effectiveness in the development of key competencies. However, it also highlights the need for more contextualized research in Colombia and for a more balanced approach to the study of the three competencies assessed by ICFES. Future studies should focus on the adaptation and evaluation of PBL models specifically designed for the Colombian educational context, with a particular emphasis on how this methodology can address the competencies of social thinking, interpretation and analysis of perspectives, and reflective and systemic thinking in the framework of ICFES assessments.

Discussion and Conclusions

This systematic review of Project-Based Learning (PBL) in social science teaching reveals significant findings and crucial gaps in current research. The studies reviewed demonstrate valuable methodological diversity and provide consistent evidence of the benefits of PBL in the development of critical thinking skills and historical analysis in diverse geographic contexts. This methodological diversity, which includes qualitative, quantitative and mixed studies, strengthens the validity of the findings and provides a more complete understanding of the effectiveness of PBL in different educational settings.

However, the review has also revealed significant weaknesses in the existing literature. The paucity of longitudinal studies limits the understanding of the long-term effects of PBL on the development of social science skills. In addition, the limited research

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in the Colombian context regarding the research problem raises questions about the direct applicability of international findings to the country's educational system. This gap is particularly problematic given the specific focus of the competencies assessed by the ICFES in Colombia.

The lack of uniformity in the measurement of competencies emerges as another notable weakness. This inconsistency makes direct comparison between studies difficult and hinders the formulation of solid conclusions about the relative effectiveness of PBL in different contexts. Future studies should address this limitation by developing and using standardized assessment instruments that are aligned with the specific competencies assessed in the Colombian context.

The results suggest a significant potential of PBL to develop key competencies in social sciences. In particular, several studies highlight the effectiveness of PBL in fostering critical thinking skills, analysis of historical sources, and understanding of multiple perspectives. These findings are promising for the development of the competencies of social thinking and interpretation and analysis of perspectives assessed by the ICFES. However, the evidence is less clear on the development of reflective and systems thinking, suggesting an area that requires further research.

The lack of studies that specifically address the competencies assessed by ICFES - social thinking, interpretation and analysis of perspectives, and reflective and systems thinking - represents a significant gap in the literature. This shortcoming limits the ability of Colombian educators and educational authorities to make informed decisions about the implementation of PBL in the social sciences curriculum.

This review contributes to the advancement of knowledge by identifying this critical gap and providing a solid foundation for future studies and for the adaptation of PBL to the Colombian educational context. The novelty of the work lies in its specific focus on ICFES competencies and in the identification of the gaps between international research on PBL and the particular needs of the Colombian educational system. This approach has not been previously addressed in the literature, which makes this article an original and valuable contribution to the field.

The findings also underscore the importance of considering practical challenges in implementing PBL. Several studies point to obstacles such as lack of time, limited resources and the need for teacher professional development. These factors should be carefully considered in any attempt to integrate PBL into the social science curriculum in Colombia.

In conclusion, there is an urgent need for contextualized research on the application of PBL to develop the specific social science competencies assessed in Colombia. It is necessary to adapt PBL to the Colombian educational context, taking into account the socioeconomic and cultural realities of the country. In addition, it is crucial to develop assessment instruments aligned with the ICFES competencies, which allow for accurate and consistent measurement of the impact of PBL on the development of these competencies.

Longitudinal studies are strongly recommended to evaluate the long-term effectiveness of PBL in the development of social science competencies. These studies should examine not only academic performance, but also the development of critical thinking skills, the capacity for historical analysis and the understanding of complex social systems.

Finally, it is important that future studies explore how PBL can be effectively integrated with other pedagogical strategies and educational technologies to maximize its impact on competency development. Future research should also consider how PBL can

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be adapted to address existing educational inequalities in Colombia and promote more equitable access to quality social science education.

These actions are crucial to inform educational policies and teaching practices, promoting a more effective and contextualized teaching of social sciences in Colombian secondary education. Only through rigorous and contextualized research will we be able to take full advantage of the potential of PBL to improve social science education in Colombia and prepare students for the challenges of the 21st century.

Consequently, despite the wealth of research on PBL in social science teaching, there is a significant gap in the literature when it comes to specifically addressing the competencies assessed by the ICFES in the Colombian context. This void manifests itself in several aspects:

1. Lack of focus on specific competencies: None of the aforementioned studies focus directly on how PBL could develop social thinking, perspective interpretation and analysis, and reflective and systemic thinking as defined in the Colombian curriculum framework. This gap is crucial, as these competencies are the basis for evaluation and curriculum development in Colombia.

2. Lack of contextualization to the Colombian educational system: Martínez-Rodríguez and Sánchez-Agustí (2018) point to the need for more contextualized research in national education systems. This observation highlights the importance of examining the applicability of PBL in the development of specific competencies in the Colombian curriculum, considering the particularities of the country's educational system.

3. Lack of longitudinal studies: Hernández-Ramos and De La Paz (2009) note that while PBL shows promising results in history learning, more research is needed to determine how this methodology can be adapted to develop specific competencies over time. This observation underscores the need for long-term studies examining the impact of PBL on the development of social science competencies.

4. Gap in PBL adaptation for specific competencies: Brush and Saye (2014) argue that there is still a gap in understanding how PBL can be adapted to develop more sophisticated historical thinking skills. This observation is aligned with the need to investigate how PBL can foster competencies such as the interpretation and analysis of perspectives in the context of Colombian social sciences.

5. Lack of integration between theory and practice: Although there are numerous pedagogical productions in the field of the teaching-learning process of social sciences related to PBL, little or no concrete work has been done to develop competencies in social sciences through this pedagogical approach. This gap between theory and practice limits the applicability of existing findings in the Colombian educational context.

6. Absence of specific evaluation tools: No studies have been identified that provide specific assessment tools or methods to measure the development of social science competencies through PBL, particularly in the context of ICFES assessments.

7. Lack of comparative studies: There is a lack of research comparing the effectiveness of PBL with other pedagogical approaches in the development of specific competencies in social sciences as assessed by the ICFES.

This gap in knowledge underscores the urgent need for contextualized research that can inform educational practice in Colombia. Studies are needed that specifically examine how PBL can be adapted and applied to develop the social science competencies defined by the ICFES, considering the particularities of the Colombian educational system and the specific needs of secondary school students in the country.

The review of the available evidence has revealed a significant body of research on PBL in social science teaching, but it has also revealed an important gap in terms of its specific application to develop the competencies assessed by the ICFES in Colombia. This gap underscores the need for contextualized research that can inform educational practice in the country.

This literature review seeks to contribute to the educational field by providing a solid foundation for future research and pedagogical practices that effectively integrate PBL with the development of social science competencies in Colombia. The results of this study have the potential to inform educational policies and teaching practices, promoting a more effective and contextualized teaching of social sciences in Colombian secondary education.

the article's conclusions will be presented in a final section, followed by the main conclusions.

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Relationship between musical training and working memory in adolescent between 12 and 14 years old from the San Vicente district, province of Buenos Aires

Relación entre el entrenamiento musical y la memoria de trabajo en adolescentes entre 12 y 14 años del partido de San Vicente, provincia de Buenos Aires

Daniela González Costa
Universidad de la Serena, Argentina (danielagonzalezcosta@gmail.com)(http://orcid.org/0009-0008-5903-0390)

	ABSTRACT
Keywords: Musical training, working memory, transfer, adolescent.	The objective of this master's thesis was to evaluate the impact of the program of a youth orchestra in the Province of Buenos Aires on the operability of working memory, executive functions and verbal working memory with standardized tests. A transectional study was carried out, where two groups of adolescent participants were compared, with and without musical training. Significant differences were found in favor of the group with musical training in the direct digit tests, reverse digit tests and the verbal comprehension subtests (similarities, vocabulary and comprehension), adding to the studies that affirm that musical training affects working memory verbal. No significant differences were found in the other tests. Finally, it is concluded that the youth orchestra program benefits some aspects of cognitive development in its participants.
	RESUMEN
Palabras clave: Entrenamiento musical, memoria de trabajo, transferencia, adolescentes.	La presente tesis de maestría tuvo por objetivo evaluar el impacto del programa de una orquesta juvenil de la Provincia de Buenos Aires en la operatividad de la memoria de trabajo, las funciones ejecutivas y la memoria de trabajo verbal con pruebas estandarizadas. Se realizó un estudio transeccional, donde se compararon dos grupos de participantes adolescentes, con y sin entrenamiento musical. Se hallaron diferencias significativas a favor del grupo con entrenamiento musical en las pruebas de dígitos directos, dígitos inversos y las sub pruebas de comprensión verbal (semejanzas, vocabulario y comprensión), sumándose a los estudios que afirman que el entrenamiento musical afecta la memoria de trabajo verbal. No se hallaron diferencias significativas en las demás pruebas. Finalmente, se concluye que el programa de orquesta juvenil beneficia algunos aspectos del desarrollo cognitivo en sus participantes.

Introduction

The broad field of studies investigating the brain and music has currently focused on investigating how the active practice of music can bring about lasting changes (Hallam, 2010) in brain organization and plasticity (Kraus & Chandrasekaran, 2010). In comparative type studies between populations with and without music training, it is investigated whether music training would lead to a transfer of skills from music to other music-related or non-music related fields (Miendlarzewska & Trost, 2014). As a consequence, beneficial effects on cognitive functions have been found in musically trained children and adolescents (Ciaroti et al., 2019) in both musical and non-musical skills (Custodio & Cano-Campos, 2017). In the last decade, cortical areas of hearing have been found to be more sensitive to auditory information in adult musicians compared to participants without this type of training (George & Coch, 2011), while, in children and adolescents, music favors brain development and stimulation of intellectual capacities for cognitive development and learning (Arenas, Lázaro, & Sánchez, 2016). In addition, greater brain plasticity has been found in subjects who have undergone musical training since childhood (Benítez, Diaz Abrahan & Justel, 2017; Wan & Schlaug, 2010), depending on the duration and experience of the training (Vaquero, Rousseau, Vozian, Klein & Penhune, 2020).

In studies of brain neuroimaging recordings, it has been found greater connectivity in adults and children with musical training (Arias, 2014), due to a repeated activation in areas of the prefrontal cortex in areas of the prefrontal cortex, where working memory is located (Peretz & Zatorre, 2005; Zuk, Benjamin, Kenyon & Gaab, 2014), cognitive control or control of mechanical automatic responses (Pallesen et al., 2010) and attention (Jurado, 2016). Anatomical modification has been found in this area in adult musicians, due to the ability to reorganize as cognitive demand requires (Hallam, 2010; Soria-Urios, Duque & García-Moreno, 2011).

Within the structural modifications of brains of musically trained children, the most important is the increased activation of the auditory cortex and plasticity throughout the auditory system (Elangovan, Payne, Smurzynski & Fagelson, 2016)due to the need to manage auditory elements over time (Hyde et al., 2009). This could be explained by the fact that children with early musical training demonstrated a more extensive cortical representation (auditory cortex) than untrained children (Wan & Schlaug, 2010). Based on neuroscientific findings, it specifies what musical training consists of and how this complex and demanding training benefits motor, articulatory and cognitive development in children, adolescents and adults.

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Method

The research design and methodology is transectional or cross-sectional, non-experimental, causal between variables (Hernández Sampieri, Fernández Collado & Baptista Lucio, 2010). The relationship between an independent variable (musical training) and dependent variables (working memory, verbal working memory, executive functions) was investigated without manipulation of variables (non-experimental).

Working Memory Subtests

Participants performed standardized WISC-IVtests (Wechsler, 2010), specifically the working memory index tests (direct digits, reversed digits, letters and numbers), verbal comprehension (similarities, vocabulary and comprehension) and the Corsi cube task (Corsi, 1972) in progression. The direct digit and inverse digit subtest calculates the working memory IQ. The Similarity, Vocabulary and Comprehension subtest calculates the IQ of verbal comprehension.

Digit retention. He required the child to repeat the digits presented, modifying his request into direct (the same order presented) and inverse (the opposite order to the one presented). Digit retention has an oral presentation and is designed to measure short-term auditory memory and the ability to sequence attention and concentration (Wechsler, 2010). Direct digit retention according to Wechsler (2010) involves memory and mechanical repetition learning, attention, encoding and auditory processing, while inverse digit retention involves working memory, information transformation, mental management, imagination, cognitive flexibility and mental alertness.

Letters and numbers. It is a subtest composed of a task of orally repeating a sequence of letters and numbers combined, first the numbers in ascending order and then the letters in alphabetical order. This task involves sequence formation, mental management of information, attention, auditory short-term memory, visuospatial image formation and processing speed (Wechsler, 2010).

Corsi cubes in progression. It consists of presenting visuospatial information by means of nine painted wooden cubes, arranged in a non-exact square. The researcher touched the cubes one by one and the participants observed and repeated what they observed by touching the cubes, respecting the sequence presented. This task is characterized by having the same digit logic (working memory), where each series was expanded and made more complex to the maximum level that the participant could remember (9 combinations of cubes). This study completes the evaluation of working memory by providing information on visuospatial retention.

Verbal Comprehension Subtests

Similarities. It is the main subtest in verbal comprehension, where two words representing common objects were presented and the child had to describe verbally how they were similar. This task is designed to measure verbal reasoning and concept formation, in addition to auditory comprehension, memory, distinction between essential and secondary features, and verbal expression (Wechsler, 2010).

Vocabulary. In this subtest, the presentation has four graphic items and four verbal items, designed to measure word knowledge and verbal concept formation by first seeing and recognizing information and then hearing a word. It measures wealth of knowledge, learning ability, long-term memory and degree of linguistic development (Wechsler, 2010).

Comprehension. This test has a question mode and is designed for the child to respond verbally - based on an understanding of a series of general principles and social situations - what a concept or object is good for or what is good about it. It measures concept formation and verbal reasoning, verbal expression and comprehension, the ability to evaluate and use experience, and the ability to handle practical information (Wechsler, 2010).

Results

The results were analyzed with the *Statistical Package for the Social Sciences* (SPSS), performing the following analyses: i) Shapiro Wilk normality test to define the use of non-parametric statistics; ii) the Chi-square statistic was used to evaluate the sociodemographic variables, specifically the total household income and gender of the participants, in relation to two groups of children, with and without musical training; and iii) the mann Whitney U statistic was used to analyze the quantitative variables, corresponding to the parents' schooling and the individual income of the father and mother; adding the subtests of working memory and verbal comprehension performed by the participants.

Results analysis of sociodemographic data. No significant differences were found between groups in age (U = 169.5, p = 963), father's schooling (U = 133.5, p = 221), mother's schooling (U = 143.5, p = .359), father's income (U = 171, p = 1.0), mother's income (U = 159.5, p .699), or total income(U = 159.5, p = .723). Nor were differences found in relation to children's gender (X^2 = .232, p = .630) or parent-reported work (X^2 = 8.9, p = .254). These data allow us to affirm that both samples were similar.

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Statistical analysis sub MO and CV tests

Working memory.

Significant differences were found between groups, with better performance by the music-trained group in direct digits (U = 38.5, p < .0001), inverse digits (U = 51.5, p < .0001), not so in letters and numbers (U = 126.5, p = .172), or Corsi cubes (U = 170.5, p = .985). The results are shown in Figures 1, 2, 3, and Table 8.

Figure 1. Direct Digits
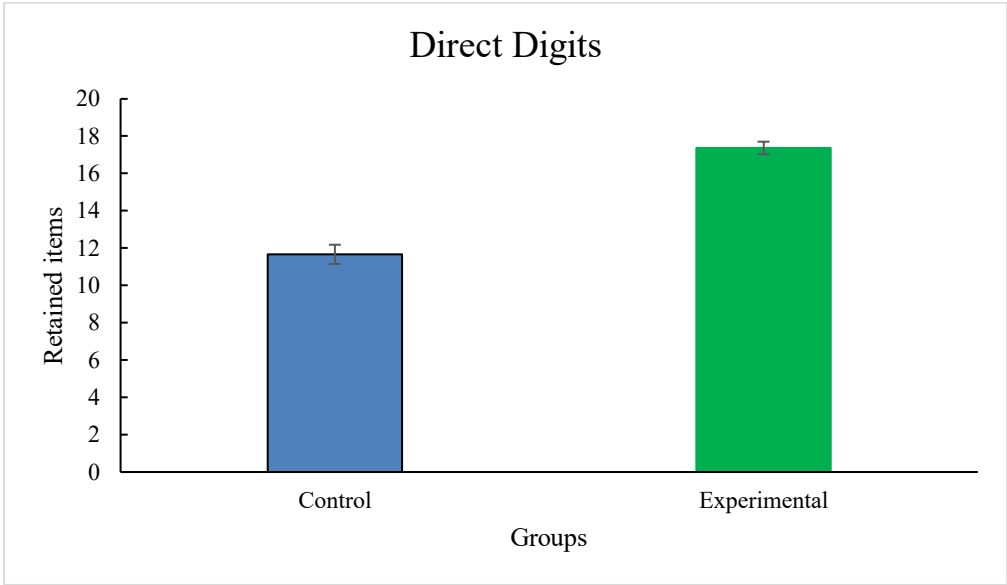
Figure 2. Inverse Digits
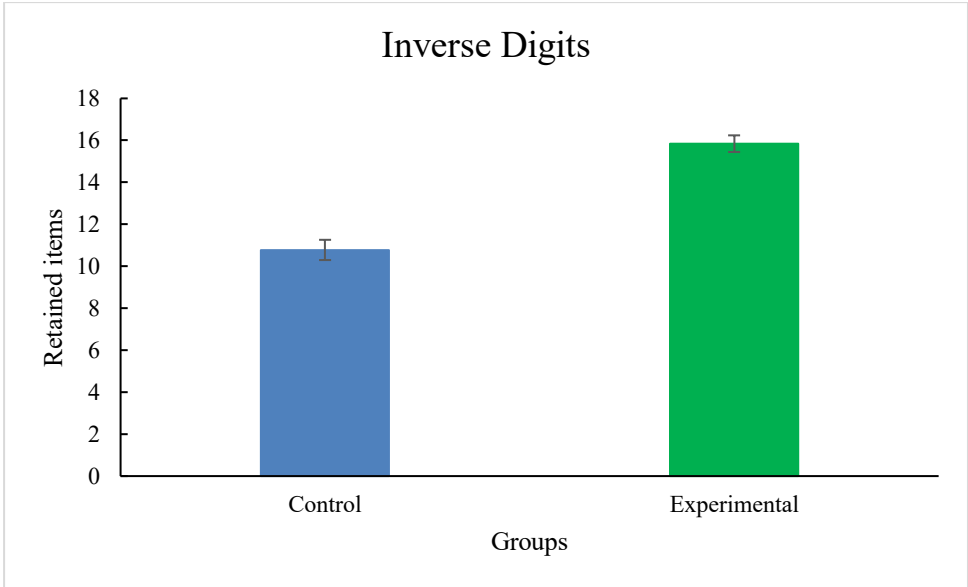
Figure 3. Letters and Numbers
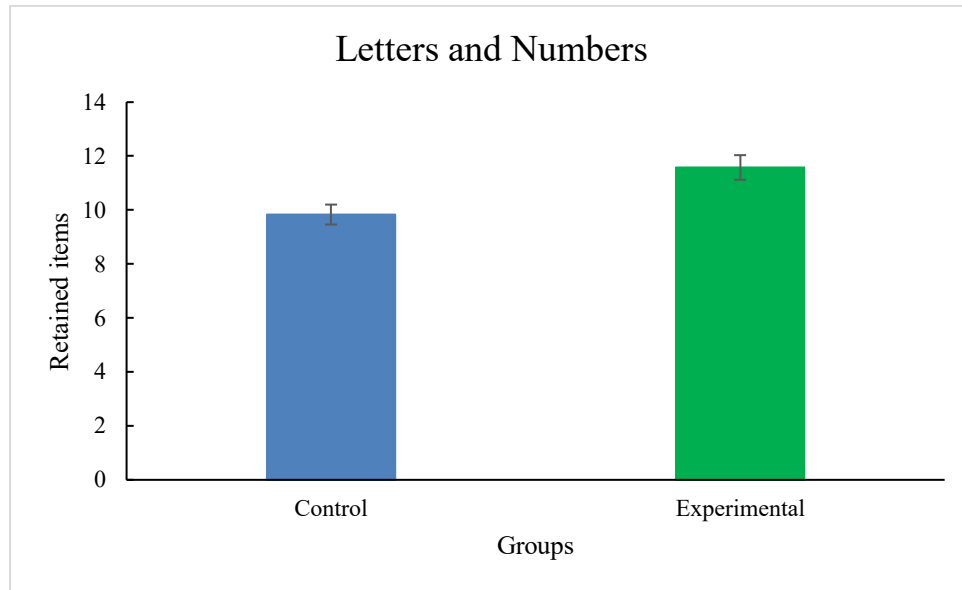
Table 8. Corsi Cubes

Training musical	N	Average range	Sum of ranks
Boys and girls (1)		19.03	342.5
	18		
Boys and girls (2)			360.5
	19	18.97	
Total	37		

(1) Without musical training; (2) With musical training

Verbal Comprehension.

In relation to this item, differences were found in similarity ($U = 52$, $p < .0001$), vocabulary ($U = 34.5$, $p < .0001$) as well as comprehension ($U = 43.5$, $p < .0001$) in favor of the group with musical training. The results are shown in Figures 4, 5, and 6.

Figure 4. Similarities

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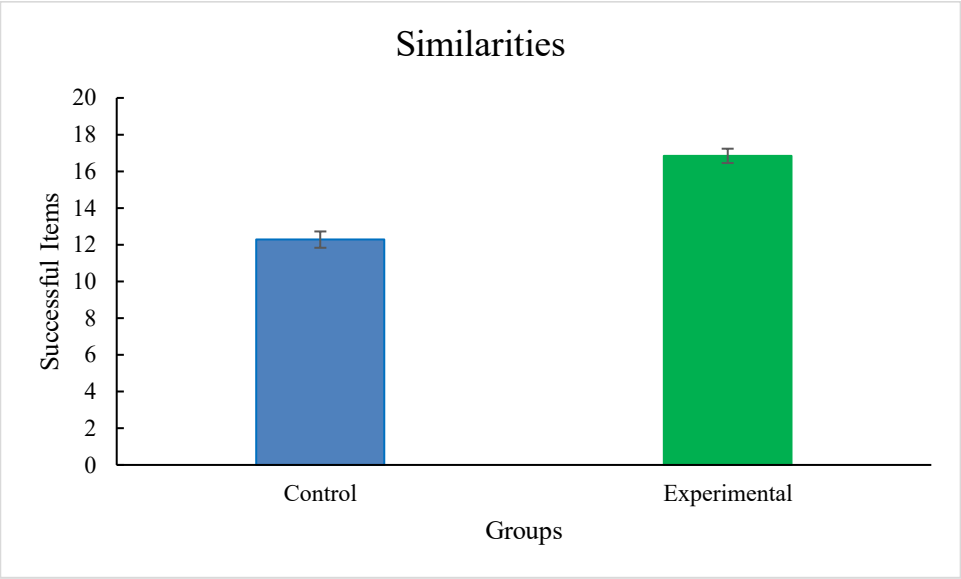
Figure 5. Vocabulary
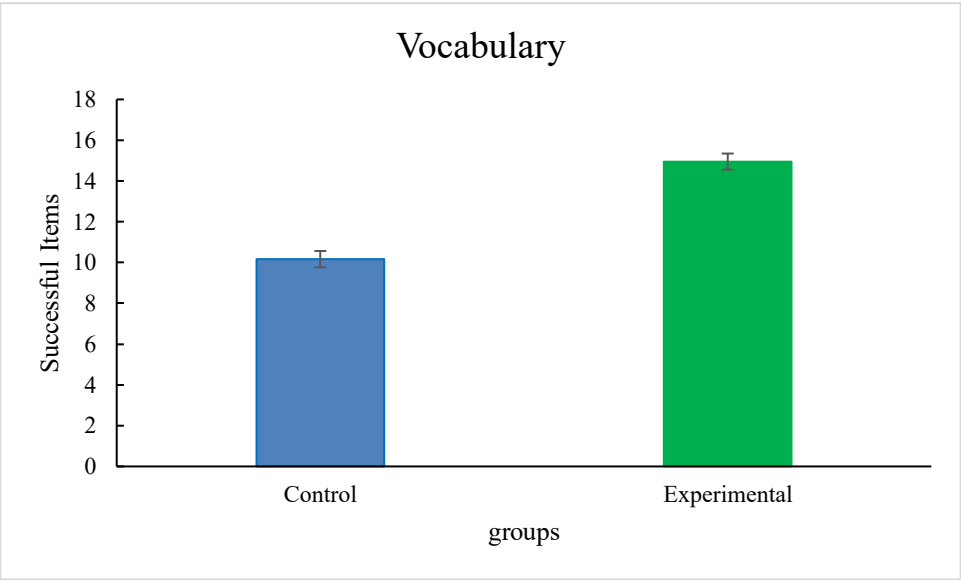
Figure 6. Comprehension
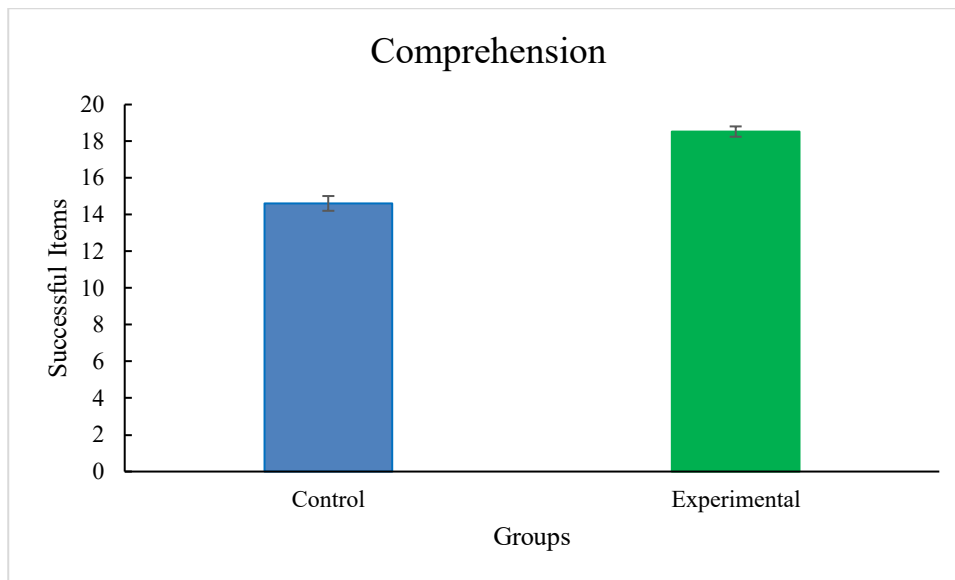
Discussion and Conclusions

In the specific objectives of this cross-sectional research, the performance of working memory was measured, analyzed and compared, specifically in auditory information retention tasks (digit retention task) and visuospatial information retention tasks (Corsi Cubes test). Verbal comprehension was added specifically in similarity, vocabulary and comprehension tasks. The results obtained in the data analysis showed that the adolescents with musical training had a better handling of direct and inverse digits compared to those without musical training, with no results in the Corsi cubes, so that musical training possibly does not affect visuospatial skills.

Transfer of Skills

Within the theoretical framework, the most important finding is the effects of musical learning and training on the transfer of knowledge to non-musical skills. Mainly, musical training has been associated with an increase in operative skills, verbal working memory and executive functions, due to the inhibition and cognitive control required by the skill of a musical instrument (Medina & Barraza, 2019; Moreno & Farfán, 2015); in addition, it also adds to the development of working memory in auditory information (verbal and auditory; Roden et al, 2012; Taylor & Dewhurst, 2017).

For example, in previously presented antecedents in preschool populations, music lessons and music practice, whether vocal or instrumental, have been found to positively affect verbal working memory skills in vocabulary growth and melody learning (Kim et al, 2018), while, in children and adolescents, greater general and domain-specific cognitive development, such as IQ (Roden et al., 2014) and verbal working memory (Alonso, 2017), has been seen. In addition, music is a training that enhances and flexes executive functions in the operative development of these non-musical skills, allowing the positive effects to extend across a wide range of intelligence skills (Vaquero et al., 2020).

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Working Memory and Executive Functions

In working memory and executive functions, beneficial effects of musical learning and training on knowledge transfer to non-musical skills have been reported in several domains of general and specific intelligence (Miendlarzewska & Trost, 2014). In a working memory analysis, studies that measured visuospatial and verbal skills selected Wechsler tests for this type of assessment (Alonso, 2017; Francoise et al., 2012; Linnavalli et al., 2018; Moreno et al., 2012; Roden et al., 2012; Schlaug et al., 2005) with only one evidence of a distinct selection of batteries, also with findings of greater working memory in children with musical training (Cohrdes et al., 2018). Those who evaluated working memory and verbal comprehension, used vocabulary and comprehension tests, finding favorable results and associated with auditory and operative effects of musical training (Alonso, 2017; Degé et al., 2011; Francois et al., 2012, Roden et al., 2012).

Phonological Ability

Phonological ability and in general learning that depends on auditory is related to the development of multimodal skills of working memory (Alonso, 2017), considering that it is not possible to develop phonological ability and operational type skills without cognitive or inhibitory control of executive functions, since it is an essential function in working memory performance (Diamond, 2013). Therefore, musical training operates auditory information as auditory training, achieving higher performance and sub-vocal, vocal and phonological production in auditory tasks. As a transfer of knowledge, phonological skill is considered a close transfer, because it is in the same domain as musical, articulatory and auditory learning. The development of short auditory elements, such as auditory discrimination or recognition, is highlighted (Miendlarzewska & Trost, 2014).

Attention

On the other hand, in the attention, both Barbaroux et al. (2019), Bugos and DeMarie (2017), Degé et al. (2011), Francois et al. (2012), Jurado (2016) Linavalli et al. 2018 as Sportsman (2011), selected the NEPSY test for evaluation, without finding any favorable results that can be associated with musical learning or training in these tests. Generally, attention has been related to the cognitive development of the child's growth, since the older the child is, the more likely it is to find favorable performance in the participants, so it was not a skill that was presented as important in the theoretical or methodological background of this research.

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Relationship between nutrition and cognitive processes that affect academic performance in adolescent students

Relación entre nutrición y procesos cognitivos que inciden en el rendimiento académico en estudiantes adolescentes

Dora Carolina Jaimes Crispín
International Iberoamerican University, Mexico (doracj@gmail.com) (https://orcid.org/0009-0002-0698-5384)

	ABSTRACT
Keywords: adolescents, eating habits, nutrition, cognitive processes, academic performance.	The study focuses on determining the relationship between nutrition and cognitive processes that affect academic performance in adolescent students. It is a non-experimental, quantitative, descriptive and cross-sectional research. 189 students, with an average age of 15, were selected as a sample. years. The dependent variable is made up of the school performance of the study population, determined through the Saber Tests and grade sheets and indirectly through neuropsychological tests, such as the TMT Test A and B, which measures the cognitive process of attention. and the Wisconsin test that measures executive functions and the Auditory Memory test that measures the memory process. The main independent variable of this study will be the anthropometric nutritional status of the students, determined through the calculation of BMI and hemoglobin. It is concluded that the relationship between BMI and hemoglobin with the different tests is weak, as is BMI and hemoglobin with the grades and results of the Saber Tests. Although the participating students present a high risk of acquiring eating habits that result in nutritional deficiencies. The results obtained show that the BMI in the majority is within normal ranges as well as hemoglobin, they also have good sleeping habits and the results of academic performance measured by grades and Test Saber are not as low as initially expected.
	RESUMEN
Palabras clave: adolescentes, hábitos alimenticios, nutrición, procesos cognitivos, rendimiento académico.	El estudio se centra en determinar la relación entre nutrición y procesos cognitivos que inciden en el rendimiento académico en estudiantes adolescentes, siendo una investigación no experimental, cuantitativa, descriptiva y de corte transversal, se seleccionaron como muestra a 189 alumnos, con edad promedio de 15 años. La variable dependiente está constituida por el rendimiento escolar de la población en estudio, determinada a través de las Pruebas Saber y las planillas de notas e indirectamente a través de tests neuropsicológicos, tales como el Test TMT A y B que mide el proceso cognitivo de atención y el test de Wisconsin que mide las funciones ejecutivas y el test de Memoria Auditiva que mide el proceso de memoria. La principal variable independiente de este estudio será el estado nutricional antropométrico de los estudiantes, determinado a través del cálculo del IMC y de la

hemoglobina. Se concluye que la relación entre el IMC y la hemoglobina con los diferentes test es débil al igual que el IMC y la hemoglobina con las notas y los resultados de las Pruebas Saber. Aunque los estudiantes participantes presentan un alto riesgo de adquirir hábitos alimenticios que redundan en deficiencias nutricionales. Los resultados obtenidos demuestran que el IMC en la mayoría está dentro de rangos normales al igual que la hemoglobina, igualmente tienen hábitos de sueño bueno y los resultados del rendimiento académico medidos por las notas y Prueba Saber no son tan bajos como se esperaba inicialmente.

Introduction

Adolescence is characterized by an accelerated growth rate, changes in body composition, appearance of secondary sexual characteristics, and emotional and psychosocial maturation. These characteristics influence both the dietary recommendations for this stage of life and the eating habits of young people.

Often the young person does not agree with the eating habits of the family, including attempts to follow special diets (e.g. vegetarian diet), with the independence that is generated at this specific age stage there is an increase in activities outside the home; alterations in eating schedules, skipping some meals (breakfast, lunch) and increased consumption of fast food, sweets and energy drinks. At the same time, decrease the consumption of dairy products, fruits and vegetables, dinner can become the main meal of the day. In addition to these eating habits, sedentary lifestyles increase the risk of obesity and other chronic diseases.

The interest in investigating the relationship between nutritional status and cognitive processes involved in academic performance is situated within the framework of the Sustainable Development Goals (SDGs) and arises from experiences lived in the institution in which students come, mostly from low-income families, exposed to the consumer society that preaches the neoliberal model, so they present a high risk of acquiring eating habits that result in nutritional deficiencies; in turn, this condition is reflected in a level of academic performance below what is required for these adolescents to compete successfully in the labor market.

From the teaching practice it has been possible to observe that in the institution under study there is a low academic performance in 9th grade students, who are mostly adolescents. The causes may be multiple, since there is a clear interdependent relationship between biological, cognitive and contextual factors, but it has been identified that most students come from low-income families, which hinders their development. This problem of low performance is not exclusive to this social sector, as it can be found in the general student population.

The particularity identified as a possible causal factor of the low academic performance in the aforementioned population is the state of malnutrition in which the students can be observed, given the food environment in which they develop. As the population is primarily adolescent, it can be understood that this stage of life is one in which physical and psychosocial development and adequate nutrition are not only essential for present well-being but also for future health and prosperity.

In addition, the adolescent experiences variations in academic performance due to the pressures of evaluations and even more so due to the exhortation of vocational determination. It is in adolescence that the maturation process of the executive functions is defined or culminates, so that the individual becomes an adult with adequate cognitive tools to perform in the real context. To this end, the socio-demographic and economic characterization of the study population, as well as their eating habits, was initially carried out. The anthropometric nutritional status of the 9th grade students of the

institution under study was estimated through the body mass index. Additionally, the hemoglobin concentration of 9th grade students is determined. The results obtained in the application of the TMT, logical thinking, auditory memory, M-WCST and school performance tests are presented.

The relationship between nutritional status and cognitive processes measured through the tests in the study population is clarified. The relationship between the biochemical indicator hemoglobin and the cognitive processes measured through the tests in the study population is evaluated.

Finally, the relationship between the nutritional status of the 9th grade students of the institution studied in relation to their academic performance is established. And finally, the relationship between nutritional status and the biochemical indicator of hemoglobin in the blood of the 9th grade students studied in relation to their academic performance is compared.

Method

The study is quantitative, descriptive and cross-sectional. According to Valdés, P. (2006), quantitative research is reduced to measuring variables in terms of a given magnitude or quantity; the aspects that characterize quantitative research are measurement subject to mathematical criteria and numerical reproduction of the relationships between subjects and phenomena.

Likewise, quantitative research has great value in external validity, because with a representative sample of the population it is possible to infer the results of the study in that sample to the population from which it comes (Valdés, P., 2006). This type of research tries to investigate the forces of association or correlation between variables and generalizes the results through those obtained in a sample, so the results of this type of research have validity to generalize them to the population (Valdés, P., 2006)

For Hernández et al. (2014) with descriptive studies "we seek to specify the properties, characteristics and profiles of people, groups, communities, processes, objects, or any other phenomenon that is subjected to analysis, which means that it only aims to measure or collect information independently or jointly on the concepts or variables to which they refer" (p. 103)

It is cross-sectional due to the data collection, which was carried out in a single time period, coinciding with Tamayo and Tamayo (2010) who express that the purpose of a cross-sectional research is to describe conditions in order to analyze their incidence and interrelation at a specific time.

Regarding the research design, the ninth grade students of the institution in question will be integrated into the study once they have given their voluntary acceptance to participate and informed consent has been received from their parents or legal guardians and also from the school establishment in question. Every day there is more interest in the knowledge that leads to the practice of healthy lifestyle habits, among which physical activity and proper nutrition stand out, as an essential basis for maintaining the balance of a healthy life.

Sample
A sample of 189 students was selected, with an average age of 15 years, distributed in both sexes, i.e. females and males. Among the inclusion criteria, one hundred percent of the ninth grade students in the study sample of the institution studied were taken, who

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have the indicated authorization, that is, those students whose parents have signed the participation form in the research and who voluntarily commit themselves to participate in a responsible manner for as long as the research requires it.

As a criterion for exclusion, the voluntary and individual refusal of each student and/or his/her guardian or representative was established, in order to comply with the informed consent rules that apply in these cases. In addition, the exclusion criteria were students or their legal representatives who did not attend the educational sessions about the research process and, on the other hand, students who, although they attended the training given, did not follow the necessary or required recommendations and instructions. Finally, students or their legal representatives who did not sign the acceptance or informed consent form were also unable to participate.

Variables

The dependent variable of this research project is constituted by the school performance of the study population, which was measured directly through the Saber Tests and report cards and indirectly through neuropsychological tests, such as the TMT A and B test that measures the cognitive process of attention, the Wisconsin test that measures the executive functions and the Auditory Memory test that measures the memory process.

The main independent variable in this study is the anthropometric nutritional status of the students, determined by calculating body mass index (BMI) and hemoglobin. In addition, covariates such as logical thinking and cognitive processes were analyzed to explain the topic studied.

Analytical Research Instruments and Tests

For the characterization of the students, we inquired about gender, age, stratum, type of housing in which they live, parents' schooling and income, number of hours of sleep, number of hours of screen time and physical activity.

The Questionnaire, adolescents "Promoting Eating at School", was applied to inquire about food consumption patterns and perceived health of snacks, school recess activities, eating and shopping behavior during school hours and about the money spent per week to buy food or beverages outside the school area.

The Consumption Frequency Questionnaire (CFC) IASE (Healthy Eating Index) was used, in which questions are asked about the frequency of consumption of cereals, vegetables, fruits, milk and dairy products, meats, legumes, sweet sausages, soft drinks and fats. In order to know how healthy the food consumed by the students is, the instrument entitled "Harvard Plate" was applied, in which an image of 100% of their lunch is presented, and the students must indicate what percentage of the plate they consume of vegetables, fruits, whole grains and healthy protein.

In relation to the BMI assessment, height was measured using a wall measuring rod and weight was measured using a digital scale.

To investigate the development of cognitive processes, the Trail Making Test, better known as TMT, which consists of two parts A and B, was used. The examiner starts counting the execution time of part A and part B as soon as the instructions have been given and the participant has been told that he/she can start. In addition, the Logical Thinking Test was applied, which consists of ten tasks designed to evaluate five formal logical-mathematical reasoning schemes such as proportionality, control of variables, probability, correlation and combinatorics.

Additionally, the assessment of logical, numerical and associative memory was performed by applying the Immediate Auditory Memory Test (MAI). This test consists of

the following three parts: presentation of two paragraphs in order to know to what extent the student remembers the details of the news item "event", presentation of digits to be repeated in the same order and inversely and pairs of associated words (3 repetitions). The student's task is to remember which word was associated with one of the pair presented (Cordero, 1978)

Executive functions were assessed using the Wisconsin Card Sorting Test (WSCT). This version of the test was created after eliminating the 80 of the 128 response cards of the original WCST that shared more than one attribute, which is why this test is composed of 48 response cards and 4 model cards. According to Schretlen (2019) Schretlen (2019) this test allows the assessment of executive function, requires strategic planning, organized search, use of environmental information to change cognitive set, goal-oriented behavior and inhibition of impulsive responses.

For the measurement of the dependent variable (academic performance), the measurement instruments used were the teachers' report cards in the different subjects and the results of the Saber Tests, as well as the cognitive process evaluation tests. According to the Ministry of Education (2022), the Saber Tests evaluate the basic competencies formulated by the Ministry of National Education in the Basic Competency Standards. The Saber 9 tests evaluate Language, Mathematics, Natural Sciences and Citizenship Competencies.

Data Analysis

A descriptive analysis of the variables of interest was performed in which the categorical characteristics were described as percentages and their respective 95% confidence intervals (95% CI). Continuous variables were expressed as means and their corresponding Standard Deviation (SD) and as medians and their interquartile range according to their distribution.

The data analytical approach was based on the statistical comparison of the results of the nutritional variables with the data of the academic performance variables of the population referred to in the present study.

The data were recorded in Microsoft Office Excel and then exported to Stata version 15 for data processing and analysis of the results.

Results

Forty-four percent of the students who participated in the study belonged to the female gender and 56% to the male gender. One percent of the students who participated in the study are between 10 and 13 years old, 75% are between 14 and 16 years old, and 24% are between 17 and 21 years old. Sixty-two percent of the participating students belong to stratum 1, 30% to stratum 2, 6% to stratum 3, 1% to stratum 4 and another 1% to stratum 5. Forty-one percent of the participating students reside in rented housing, 29% in housing shared with other family members, and 31% reside in their own housing.

Forty-six percent of the parents of the participating students have primary schooling. 60% of the parents of the participating students have a low income level. The low educational level of parents has a negative effect on children's academic performance. It is related to poverty, lifestyles, family communication patterns, linguistic communication in the home, and children's educational expectations. In it, a minimum of

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nutritious food is purchased, leading to poor nutritional quality, which has an impact on school performance.

Most adolescents need approximately 8 to 10 hours of sleep per night. Getting the right amount of sleep is essential for anyone who wants to do well in exams or perform well in sports. But, unfortunately, many teenagers don't get enough sleep. In this regard, 62% of the participating students sleep 8 hours, 8% of the participating students sleep 9 hours and only 2% of the participants sleep more than 9 hours.

When children reach adolescence, they may lose interest in physical activity. Between school, homework, friends and even a part-time job, teens have to juggle many interests and responsibilities. But regular physical activity can help teens feel more energetic, improve concentration and look better. And regular physical activity can help your child maintain a healthy weight and prevent heart disease, diabetes and other health problems in the future. In this regard, 90% of the participating students do engage in physical activity and 10% of the participating students do not engage in physical activity. 26% of participating students spend less than 2 hours on screen and 32% of participating students spend 2 hours on screen. Therefore, it is recommended that young people can participate in sports and structured physical activities that involve musculoskeletal activities. Lifting under the supervision of a qualified adult can improve strength and help prevent sports injuries. Given the opportunity and interest, teens can improve their health through almost any activity, such as skateboarding, yoga, swimming, dancing or hitting the road. Adolescents can incorporate physical activity into their daily routines, such as walking to school, running errands, or finding an active part-time job.

During adolescence, a "growth spurt" occurs, which requires maintaining a daily intake of calcium and protein to help build muscle and bone, as well as healthy fats to promote optimal hormonal development. The results show that 61% of the participating students never or less than one day a week eat breakfast.

48% of participating students 1-6 days a week eat lunch and 48% of participating students 7 days a week eat lunch.

Seventy-one percent of participating students consume two snacks per day.

53% of the participating students consume three glasses of sugar-sweetened beverages per day. Eighty percent of participating students report consuming unhealthy snacks.

81% of participating students state that they spend school recess and lunch breaks with other students. 84% of participating students spend school recess and lunch breaks usually in other spaces. 51% of participating students state that what they eat at school is usually brought from home, bought at the school canteen and also bought elsewhere.

37% of participating students spend more than $7,000 per week on food or beverages from their school cafeteria. 50% of participating students once a week or less buy food or beverages outside the school area. 63% of participating students spend $3,000 per week to purchase food or beverages outside the school area.

Fifty-six percent of participating students daily consumed soft drinks, 24% 3 or more times per week, 14% 1 or 2 times per week, 4% less than once per week, and 3% never or almost never consumed soft drinks.

The healthy eating index indicates that 32% 1 or 2 times a week never or almost never consume cereals. 35% 1 or 2 times a week, 23% less than once a week and 21% never or almost never consume vegetables. Thirty-three percent consume fruit less than once a week and 19% never or almost never consume fruit.

Most students consume milk and its derivatives less than once a week, as well as meat and legumes. Most students consume sausages and most students consume sweets

on a daily basis. Most of the participating students consume soft drinks and fats on a daily basis.

Taking into account the information gathered through the Harvard Plate methodology, it is possible to conclude that students consume few fruits, vegetables, cereals and in greater proportion in some of the plate is composed of protein. Through the data obtained it is possible to affirm that most of the students belong to low strata such as stratum 1 and stratum 2, likewise most of the students' parents have low incomes, do not have any level of education or have schooling levels such as only elementary school.

Regarding eating habits, most students never or less than one day a week eat breakfast, which means that according to Keski-Rahkonen et al. (2003) skipping breakfast reflects more than just meal timing preference, it appears to be a component of often concomitant health-compromising behaviors.

It is highlighted that 71% of the students consume snacks daily, being snacks products with high levels of sugars and fats, likewise, most of the students consume three times a day sugary drinks and in a very low percentage some of the students consume healthy snacks.

At their school breaks, students gather with their peers, but at lunchtime most students are alone at home or with other students, i.e. they do not have adult supervision to instill healthy eating. In addition, the money that students have to buy food is spent buying food and sugary drinks in the institution or sometimes they also buy them in other places.

The high consumption of sausages, sweets, soft drinks and fats per week by most of the students stands out. Additionally, it was found that most students spend more than two hours a day on the screen and do not play sports in their free time; in their free time they prefer to check social networks or spend time with their friends.

According to Martín-Aragón (2008), the foods that the human body needs are formative, energetic and regulatory, but most students consume milk and its derivatives less than once a week, as well as meats and legumes, while the consumption of sausages is 3 or more times a week. Sweets are consumed on a daily basis

According to Harvard University, red meat should be limited and processed meats such as bacon and sausages should be avoided, but most students consume sausages and most students also consume sweets on a daily basis. Most of the participating students consume soft drinks and fats on a daily basis. In addition, Harvard University stresses that most meals should contain vegetables and fruits ½ of the plate, whole grains ¼ of the plate, protein value ¼ of the plate such as fish, chicken, legumes and nuts are healthy and versatile protein sources, can be mixed in salads and combine well with vegetables in a dish, healthy plant oils, in moderation, drink water, coffee or tea, omit sugary drinks limit milk and dairy products to one or two servings a day and limit juice or juice to one small glass a day, but it is possible to conclude that students consume in low proportions fruits, vegetables, cereals and in higher proportions in some of the plate is composed of protein.

Harvard University also indicates to stay active, perform physical activity to control weight, but 3l, 90% of students do not perform physical activity.

To estimate the relationship between nutritional status and the cognitive processes measured through the tests, the correlation coefficient and the R^2 were calculated for each of the variables. Table 1 shows the relationship between BMI and TMT results.

Table 1

Relationship between BMI and TMT scores

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CORRELATION COEFFICIENT	Part A	0,13149091
	Part B	-0,0952514
COEFFICIENT R²	Part A	0,01728986
	Part B	0,00907282

BMI and TMT part A have a very weak positive relationship. The slope of the regression equation of +0.02 implies that for each unit increase in BMI, the average TMT A-time increases by 0.02 seconds. BMI and TMT part B present a very weak positive relationship. The slope of the regression equation of +0.13 implies that for each unit increase in BMI, the average TMT time B increases by 0.013 seconds, which is observed in Figure 1.

Figure 1

Relationship between BMI and TMT scores
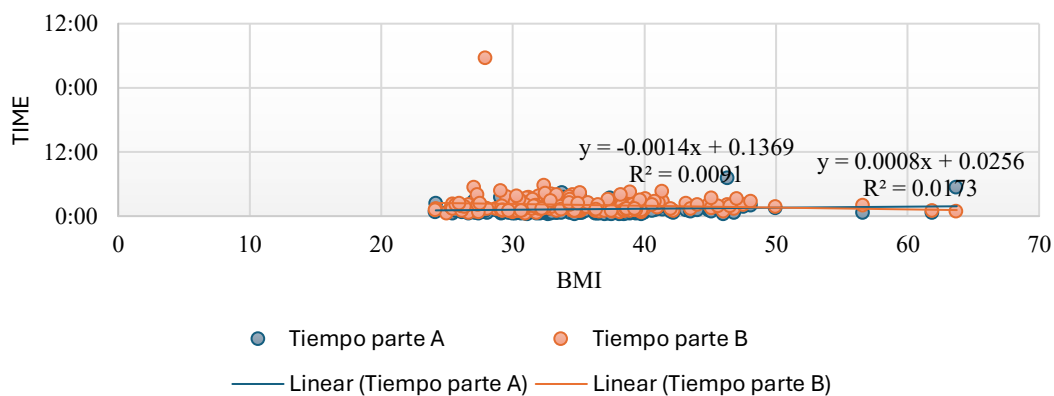
Table 2 shows the relationship between BMI and the Logical Thinking Test. BMI and logical thinking test results show a weak positive relationship.

Table 2

Relationship between BMI and the Logical Thinking Test

CORRELATION COEFFICIENT	0,07728886
COEFFICIENT R2	0,00597357

The slope of the regression equation of +3.27 implies that for each unit increase in BMI, the logical thinking test scores increase by 3.27 points. See Figure 2.

Figure 2

Relationship between BMI and the Logical Thinking Test

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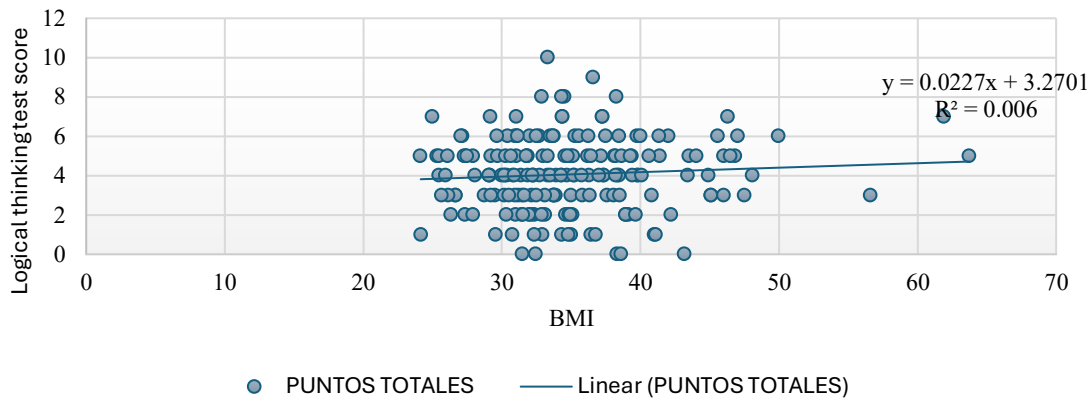
Table 3 shows the relationship between BMI and the Auditory Memory Test.

Table 3

Relationship between BMI and the Auditory Memory Test

CORRELATION COEFFICIENT	0,01090912
COEFFICIENT R2	0,00011901

BMI and auditory memory test results do not show a relationship, the correlation coefficient and R^2 are very close to zero. The slope of the regression equation of +54.17 implies that for each unit increase in BMI, the logical thinking test scores increase 54.17 points, as shown in Figure 3.

Figure 3

Relationship between BMI and the Auditory Memory Test
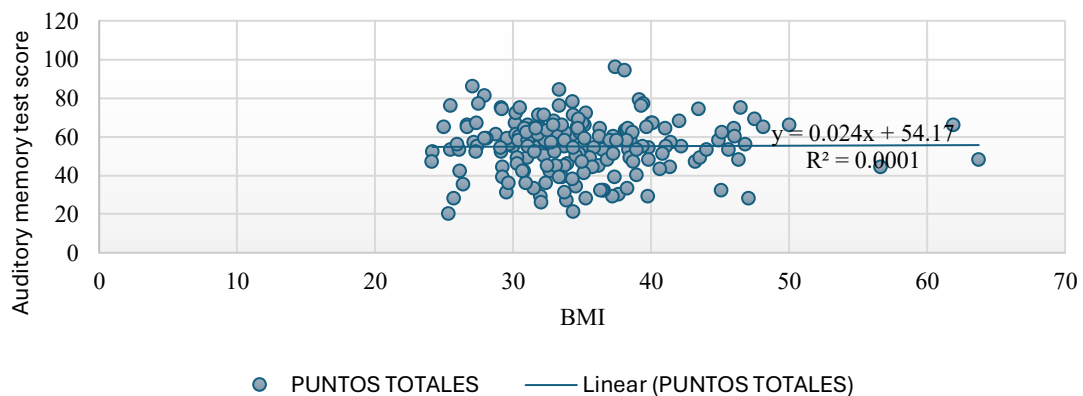
Table 4 shows the relationship between BMI and the Wisconsin M-WCST.

Table 4

Relationship between BMI and the Wisconsin M-WCST test

CORRELATION COEFFICIENT	-0,0324574

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COEFFICIENT R2	0,00105348

The BMI and the results of the Wisconsin M-WCST test by means of the correlation coefficient indicate that it could have a negative relationship, but this is weak and by means of the R^2 they do not present a relationship. The slope of the regression equation of +27.31 implies that for each unit increase in BMI, the logical thinking test scores increase by 27.31 points. See Figure 4.

Figure 4

Relationship between BMI and the Wisconsin M-WCST test

$y = -0.0457x + 27.316$
$R^2 = 0.0011$
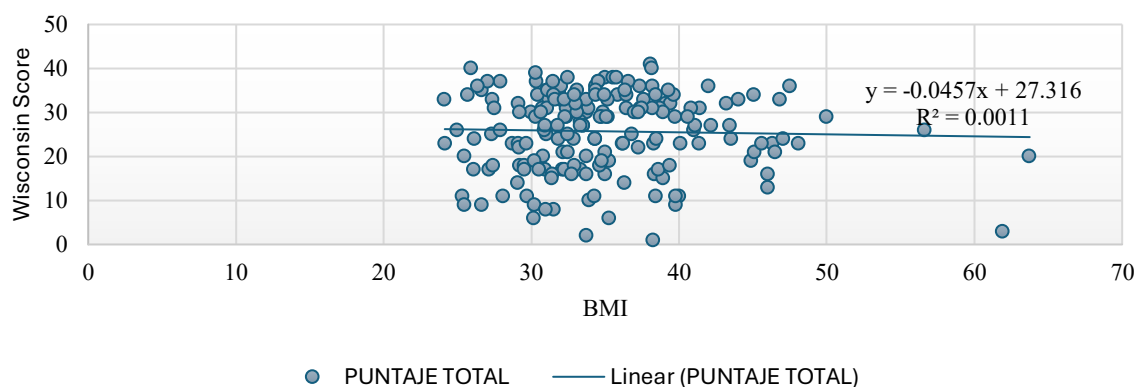
To estimate the relationship between the biochemical indicator of hemoglobin and the cognitive processes measured through the tests, the correlation coefficient and the R^2 were calculated.

Hemoglobin and TMT part A considering R^2 present a weak positive relationship. But analyzing from the correlation coefficient, they present a low negative relationship. Hemoglobin and TMT part B considering R^2 present a weak positive relationship. The correlation coefficient analysis shows a low negative relationship. Table 5 shows the relationship between hemoglobin and the TMT test.

Table 5

Relationship between hemoglobin and the TMT Test

CORRELATION COEFFICIENT	Part A	-0,1197744
	Part B	-0,0533067
COEFFICIENT R2	Part A	0,01434591
	Part B	0,00284161

The slope of the regression equation of +0.012 implies that for each unit increase in hemoglobin, the mean TMT A-time increases by 0.012 seconds. The slope of the regression equation of +0.16 implies that for each unit increase in hemoglobin, the mean TMT B-time increases by 0.16 seconds, which is seen in Figure 5.

Figure 5

*Relationship between hemoglobin and the TMT Test*

y = -0.0061x + 0.1605
R² = 0.0028

y = -0.0057x + 0.1211
R² = 0.0143

● Tiempo parte A ● Tiempo parte B —— Linear (Tiempo parte A) —— Linear (Tiempo parte B)
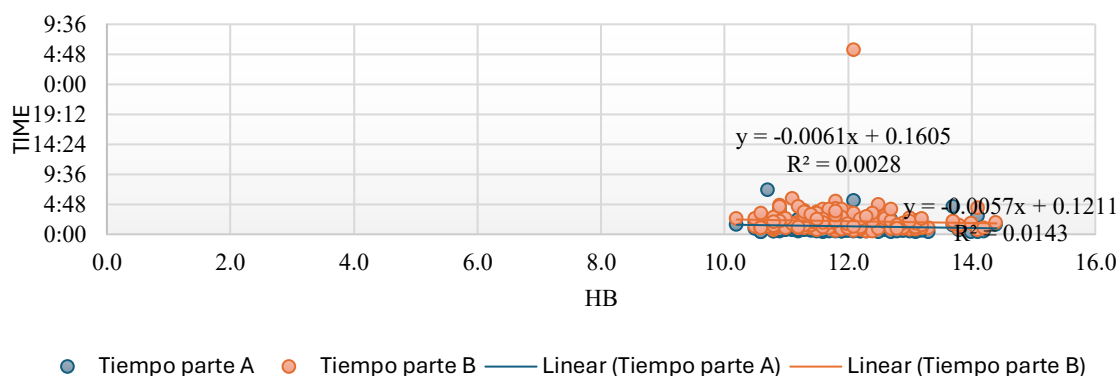
Regarding hemoglobin and its relationship with the results of the Logical Thinking Test, the R^2 presents a very weak positive relationship. But analyzing the correlation coefficient, these variables show a low negative relationship. Table 6 shows this relationship.

Table 6

Relationship between hemoglobin and the Logical Thinking Test

CORRELATION COEFFICIENT	-0,0125957
COEFFICIENT R2	0,00015865

The slope of the regression equation of +4.01 implies that for each unit increase in hemoglobin, the logical thinking test scores increase by 4.01 points. See Figure 6.

Figure 6

Relationship between hemoglobin and the Logical Thinking Test
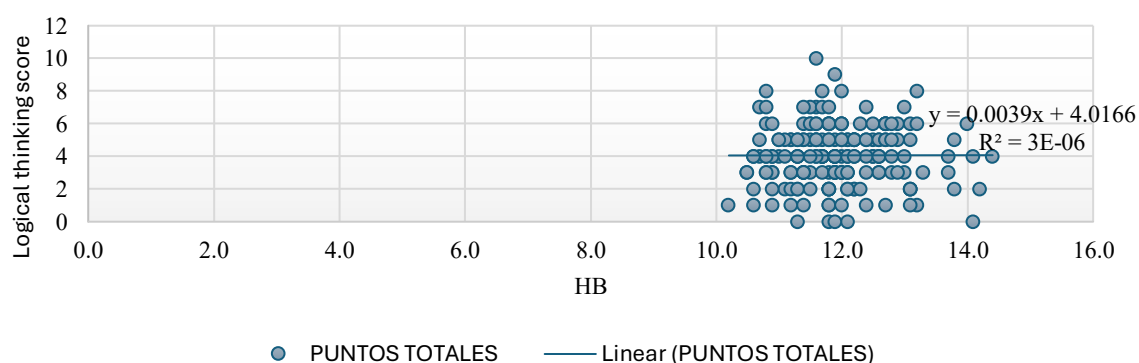
y = 0.0039x + 4.0166
R² = 3E-06

● PUNTOS TOTALES —— Linear (PUNTOS TOTALES)

Hemoglobin and the results of the Auditory Memory Test taking into account the R^2 present a very weak positive relationship. But analyzing from the correlation coefficient, they present a low positive relationship. See Table 7.

Table 7

Relationship between hemoglobin and the Auditory Memory Test

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CORRELATION COEFFICIENT	0,02312889
COEFFICIENT R2	0,00053495

The slope of the regression equation of +48.21 implies that for each unit increase in hemoglobin, the Auditory Memory Test scores increase 48.21 points, as shown in Figure 7.

Figure 7

Relationship between hemoglobin and the Auditory Memory Test

The Auditory memory test score chart showing a scatter plot with the equation $y = 0.5688x + 48.218$ and $R^2 = 0.0011$.

Hemoglobin and the results of the Wisconsin M-WCST test, taking into account the R^2, show a very weak positive relationship. However, if we analyze the correlation coefficient, the correlation coefficient shows a low positive relationship, as shown in Table 8.

Table 8

Relationship between hemoglobin and the Wisconsin M-WCST test

CORRELATION COEFFICIENT	0,0685562
COEFFICIENT R2	0,00469995

The slope of the regression equation of +15.14 implies that for each unit increase in hemoglobin, Wisconsin M-WCST scores increase by 15.14 points.

Figure 8

Relationship between hemoglobin and the Wisconsin M-WCST test

The Score tes Wisconsin chart showing a scatter plot with the equation $y = 0.8853x + 15.147$ and $R^2 = 0.0066$.

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To estimate the relationship between BMI and grades, the correlation coefficient and R^2 were calculated, as shown in Table 9. The BMI and the results obtained in the grades taking into account the R^2 present a very weak positive relationship. But analyzing from the correlation coefficient, they present a low negative relationship.
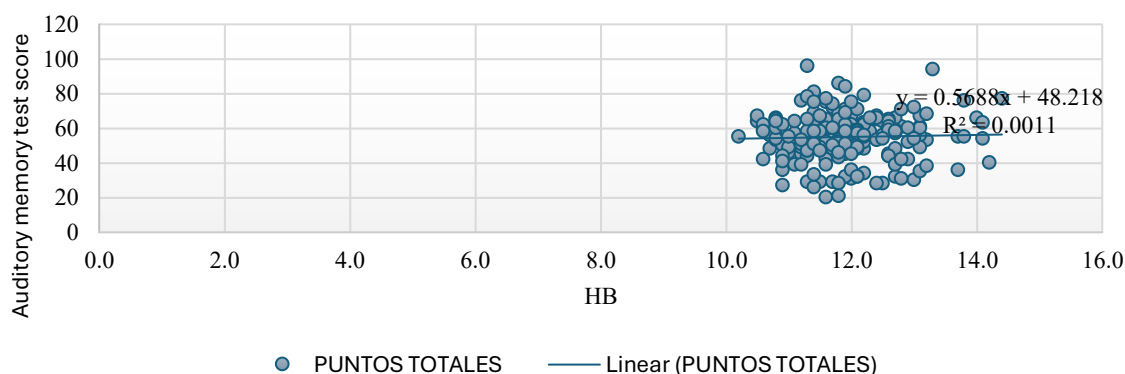
Table 9

Relationship between BMI and grades

CORRELATION COEFFICIENT	-0,1334177
COEFFICIENT R2	0,01780027

The slope of the regression equation of +81.89 implies that for each unit increase in BMI, grade scores increase 81.89 points. See Figure 9.

Figure 9

Relationship between BMI and grades
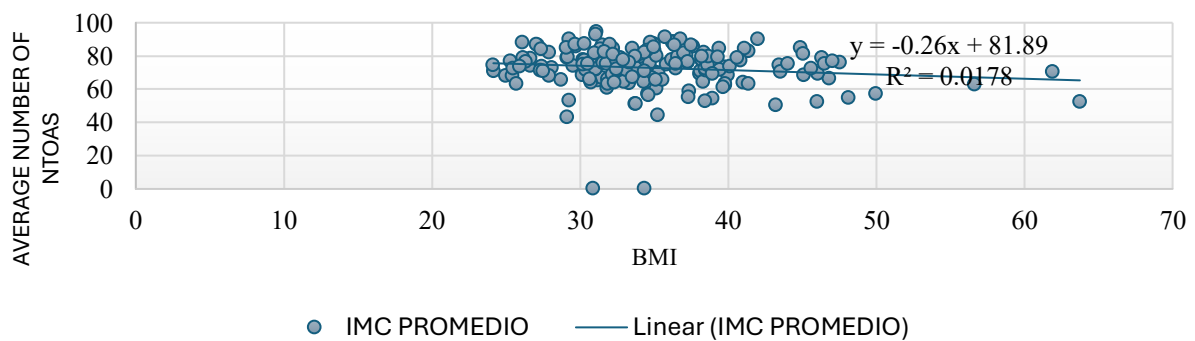
To estimate the relationship between BMI and the Saber Tests, the correlation coefficient and the R^2 were calculated. The BMI and the results obtained in the saber tests, taking into account the R^2, present a very weak positive relationship. However, if we analyze the correlation coefficient, the correlation coefficient shows a low negative relationship, as shown in Table 10.
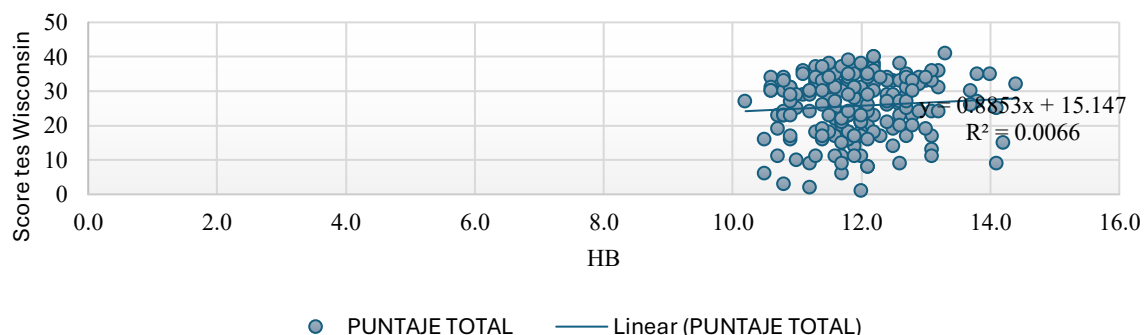
Table 10

Relationship between BMI and Saber Tests

CORRELATION COEFFICIENT	-0,1024591
COEFFICIENT R2	0,0104979

The slope of the regression equation of +39.91 implies that for each unit increase in BMI, test scores on the Saber exams increase by 39.91 points. See Figure 10.

Figure 10

Relationship between BMI and Saber Tests

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PUNTAJE TOTAL   —— Linear (PUNTAJE TOTAL)
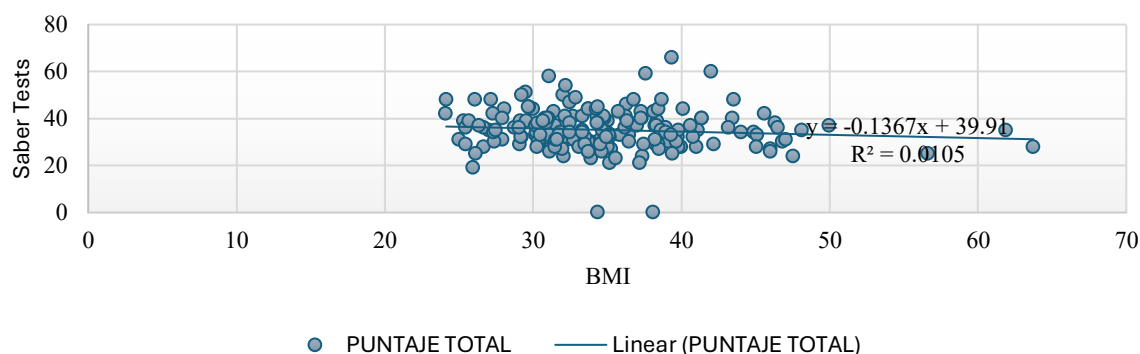
To estimate the relationship between the biochemical hemoglobin indicator and the grades, the correlation coefficient and the R^2 were calculated. Hemoglobin and the results obtained in the grades taking into account the R^2 present a very weak positive relationship. But analyzing from the correlation coefficient, they present a low negative relationship. This is shown in Table 11.

Table 11

Relationship between hemoglobin and grades

CORRELATION COEFFICIENT	-0,0397424
COEFFICIENT R2	0,00157946

The slope of the regression equation of +80.04 implies that for every unit increase in hemoglobin, grade scores increase 80.04 points, which is observed in Figure 11.

Figure 11

Relationship between BMI and grades

PROMEDIO   HB —— Linear (PROMEDIO)

To estimate the relationship between the biochemical hemoglobin indicator and the Saber Tests, the correlation coefficient and the R^2 were calculated. Hemoglobin and the results of the Saber Tests, taking into account the R^2, show a very weak positive relationship. But analyzing from the correlation coefficient, they present a low positive relationship. See Table 12.

Table 12

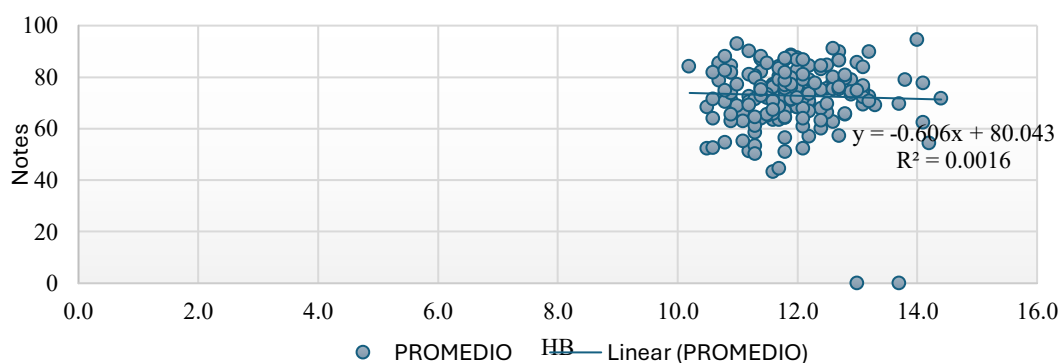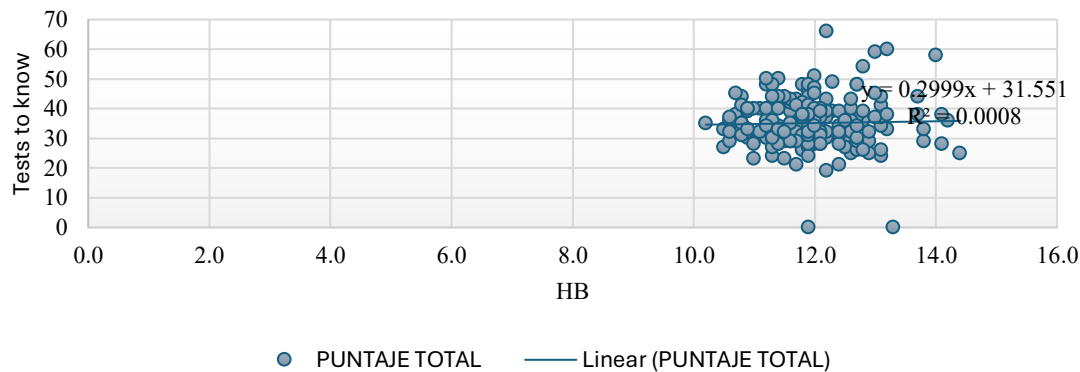*Relationship between hemoglobin and scores*

CORRELATION COEFFICIENT	0,07277475
COEFFICIENT R2	0,00529616

The slope of the regression equation of +31.55 implies that for each unit increase in hemoglobin, Saber Test scores increase 31.55 points, as shown in Figure 12.

Figure 12

Relationship between hemoglobin and the Saber Tests

Discussion and Conclusions

According to the results observed in relation to the demographic and socioeconomic classification of the participating students, 44% of the students belong to the female gender and 56% to the male gender. One percent of the students are between 10 and 13 years old, 75% are between 14 and 16 years old and 24% are between 17 and 21 years old. Therefore, there is a higher percentage of male students, although the difference is not so marked. On the other hand, most of the students are in their middle adolescence.

As for the socioeconomic stratum, 62% of the participating students belong to stratum 1, that is, the majority, and only 1% to stratum 5. There is also a high percentage, 41% of students residing in rented housing.
In relation to the educational level of the parents, 46% of the parents of the participating students have primary schooling. On the other hand, 60% of the students' parents have a low income level.

Through the data obtained it is possible to affirm that most of the students belong to low strata such as stratum 1 and stratum 2, likewise most of the students' parents have low incomes, do not have any level of education or have low levels of schooling.
The low educational level of parents has a negative effect on children's academic performance. It is related to poverty, lifestyles, family communication patterns, linguistic communication in the home, and children's educational expectations. In these family environments, a minimum of nutritious food is purchased, leading to poor nutritional quality, which affects school performance.

Regarding sleep, most adolescents need approximately 8 to 10 hours of sleep per night. Getting the right amount of sleep is essential for anyone who wants to do well in exams or perform well in sports. In this regard, 62% of the participating students sleep 8 hours, so the majority of students sleep the required hours.

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In relation to physical activity, when children reach adolescence, they may lose interest in physical activity. Between school, homework, friends and even a part-time job, teens have to juggle many interests and responsibilities. But regular physical activity can help teens feel more energetic, improve concentration and look better.

In addition, regular physical activity can help maintain a healthy weight and prevent heart disease, diabetes and other health problems in the future. In this regard, 90% of the participating students do engage in physical activity, that is to say, a large part of the students. Additionally, it was found that most students spend more than two hours a day on the screen and do not play sports in their free time; in their free time they prefer to check social networks or spend time with their friends.

Due to the rapid growth of adolescents, it is necessary to maintain a daily intake of calcium and protein for muscle and bone development, as well as healthy fats that promote optimal hormonal development. The results show that 61% of the participating students never or 1 day a week eat breakfast. The consumption of dairy products such as a glass of milk, yogurt or cream cheese, and the consumption of whole-grain carbohydrates such as two slices of whole-grain toast, sliced tomato and a slice of good quality ham, chicken or some white meat, are necessary in certain proportions depending on the daily physical activity and the condition of the adolescent.

In terms of eating habits, most students never or sometimes 1 day a week eat breakfast, which, as mentioned, is detrimental to adolescents in their physical, emotional and academic dimensions, mainly.
Regarding the frequency with which they eat lunch, 48% of the participating students eat lunch between 1-6 days a week and 48% eat lunch 7 days a week, which means that almost half of the students maintain an adequate frequency.

In relation to the consumption of snacks, sugary drinks and snacks, 71% of the participating students consumed two snacks per day, 53% consumed three glasses of sugary drinks per day and 80% of the students stated that they consumed unhealthy snacks. It is highlighted that 71% of the students consume at least 2 snacks per day, being the snacks products with high levels of sugars and fats; likewise, most of the students consume 3 times a day sugary drinks and in a very low percentage some of the students consume healthy snacks. The high consumption of sausages, sweets, sodas and fats per week by most students stands out, so these three parameters show that most students consume unhealthy foods.

Regarding school break, 81% of participating students state that they spend school recess and lunch breaks with other students. In addition, 84% of students spend school recess and lunch breaks usually in other spaces, so a large percentage of students share their time with their peers and do so in spaces other than the school restaurant. At their school breaks, students gather with their peers, but at lunchtime most students are alone at home or with other students, i.e. they do not have adult supervision to instill healthy eating.

On the other hand, 37% of students spend more than $7,000 per week on food or beverages from their school cafeteria and 63% spend $3,000 per week on purchasing food or beverages outside the school area. Additionally, 50% of the students, half of them, which is a significant number, buy food or beverages outside the school area, once a week or less. This is why the money that students have to buy their food, they spend it buying food and sugary drinks in the institution or sometimes they also buy them in other places.

In relation to the consumption of soft drinks, it is important to consider that 56% of the students consume soft drinks daily, that is, more than half of the students.
According to the results obtained in the healthy eating index, 35% of the students consume cereals 1 or 2 times a week and 33% consume cereals less than once a week,

which indicates that almost two thirds of the students consume cereals only a few days a week.

The foods that the human body needs are formative, energetic and regulatory, but most students consume milk and its derivatives less than once a week, as well as meat and vegetables; while the consumption of sausages is 3 or more times a week and the consumption of sweets, sodas and fats is done on a daily basis

Taking into account the information gathered through the Harvard Plate methodology, it is possible to conclude that students consume few fruits, vegetables, cereals and protein. According to Harvard University, most meals should contain vegetables and fruits ½ of the plate, whole grains ¼ of the plate, protein value ¼ of the plate such as fish, chicken, legumes and nuts are healthy and versatile protein sources, but it is possible to conclude that students consume in few proportions fruits, vegetables, cereals and the most remarkable is that in a low percentage of students the plate is composed of protein.

Harvard University also suggests staying active, engaging in physical activity to control weight. According to the BMI estimation, the majority of students are within the normal weight range and only 1% have type II obesity.

In the differentiation by gender, most of the female students are within the normal weight range and only 4% have type I obesity. As for the male students, approximately two thirds of the males are within the normal weight range and only 1% have type II obesity. In general, most of the students are within the normal weight range and a small proportion are obese.

Regarding the oxygen transporting protein or hemoglobin, the study shows that 45% of the female students have normal hemoglobin levels (greater than 12 g/dL), that is, no anemia, and 42% of the female students have mild anemia since they have slightly decreased hemoglobin levels (less than 12 g/dL) and 13% have moderate anemia, that is, lower hemoglobin levels (less than 11 g/dL).

As for male adolescents, 77% of male students had mild anemia, i.e., hemoglobin levels below 13 g/dL and 13% had moderate anemia, due to hemoglobin levels below 11 g/dL. It is important to emphasize that none of the students had severe anemia, i.e. hemoglobin levels below 8 g/dL, so it is concluded that all students have a normal oxygen carrying capacity.

Finally, the relationship between BMI and hemoglobin with the different tests is weak, as is the relationship between BMI and hemoglobin with grades and the results of the Saber Tests.

In this regard, it is relevant that for Hermans et al. (2017) it should be noted that adolescents have a low risk perception of unhealthy eating and seek autonomy in their food choices.

These results can be analyzed with those obtained by Lapo and Quintana (2018) by stating that in adolescents no significant relationship was evidenced between nutritional status by BMI with school performance, nor between eating habits with school performance.

In the study by González et al. (2020) also concluded that the dependence between the variables BMI and academic performance is weak.

This may be due to the fact that according to Lamas (2015) factors such as personality, motivation, aptitudes, interests, study habits, self-esteem, relationship with teachers, may cause a gap between academic performance and the performance expected from the student, which may sometimes be linked to didactic teaching methods

Although the participating students present a high risk of acquiring eating habits that result in nutritional deficiencies; which in turn, would be reflected in a

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level of academic performance below what is required for these adolescents to be successful; in this regard, the results obtained show that the BMI in most of the participating students is within normal ranges as well as hemoglobin, they also have good sleeping habits and the results of academic performance measured by the grades of the subjects and the Saber Test are not as low as initially expected.

Regarding the interpretation of the neuropsychological tests applied as an instrument to evaluate academic performance in adolescents, it is specified that for example in the case of the TMT Trail Making Test, most students passed Part A of the TMT test and almost all (99%) students passed Part B of the TMT test and only a minimum percentage (1%) of students did not pass Part B of the TMT test, which means that students have developed a good cognitive process of attention.

Through the application of the logical thinking test, out of the 18 possible points to be obtained in the test, only one student obtained 10 points, another student obtained 9 points and four students obtained 8 points. All other students scored less than 8 points.

In the Auditory Memory Test, which measures the memory process, it was observed that only 5 of the 189 students scored above 80 points, indicating that most of the students can improve this function.

Through the application of the Wisconsin M-WCST test, which measures executive functions, it is possible to observe that the number of total errors in most of the students is high, which indicates poorer performance. It should be noted that only 3 of the 189 students participating in the study obtained scores higher than or equal to 40 points, indicating better school performance.

Finally, with respect to the grades of the 14 subjects taken by CIME ninth grade students, 24% of the students had a high grade point average, 67% had a basic grade point average, and only 9% had a low grade point average. None of the students obtained a higher grade point average. Also taken into account were the scores of the Saber exams, which did not have a very high score, reaching only an average score.

BMI and TMT part A have a very weak positive relationship. The slope of the regression equation of +0.02 implies that for each unit increase in BMI, the average TMT A-time increases by 0.02 seconds.

BMI and TMT part B present a very weak positive relationship. The slope of the regression equation of +0.13 implies that for each unit increase in BMI, the average TMT time B increases by 0.013 seconds.

BMI and logical thinking test results show a weak positive relationship. The slope of the regression equation of +3.27 implies that for each unit increase in BMI, the logical thinking test scores increase by 3.27 points.

BMI and auditory memory test results do not show a relationship, the correlation coefficient and R^2 are very close to zero. The slope of the regression equation of +54.17 implies that for each unit increase in BMI, the logical thinking test scores increase 54.17 points.

The BMI and the results of the Wisconsin M-WCST by means of the correlation coefficient indicate that there could be a negative relationship, but this is weak and by means of the R^2 they do not show a relationship. The slope of the regression equation of +27.31 implies that for each unit increase in BMI, the logical thinking test scores increase by 27.31 points.

From these results it is possible to conclude that BMI has a positive relationship with the different tests applied, but it is weak.

Hemoglobin and TMT part A considering R^2 present a weak positive relationship. But analyzing from the correlation coefficient, they present a low negative relationship. The slope of the regression equation of +0.012 implies that for each unit increase in

hemoglobin, the mean TMT A-time increases by 0.012 seconds.

Hemoglobin and TMT part B considering R^2 present a weak positive relationship. The correlation coefficient analysis shows a low negative relationship. The slope of the regression equation of +0.16 implies that for each unit increase in hemoglobin, the mean TMT B time increases by 0.016 seconds.

Hemoglobin and the results of the Logical Thinking Test, taking into account the R^2, present a very weak positive relationship. But analyzing from the correlation coefficient, they present a low negative relationship. The slope of the regression equation of +4.01 implies that for each unit increase in hemoglobin, the logical thinking test scores increase by 4.01 points.

Hemoglobin and the results of the Auditory Memory Test taking into account the R^2 present a very weak positive relationship. But analyzing from the correlation coefficient, they present a low positive relationship. The slope of the regression equation of +48.21 implies that for each unit increase in hemoglobin, the auditory memory test scores increase by 48.21 points.

Hemoglobin and the results of the Wisconsin M-WCST test, taking into account the R^2, show a very weak positive relationship. But analyzing from the correlation coefficient, they present a low positive relationship. The slope of the regression equation of +15.14 implies that for each unit increase in hemoglobin, the Wisconsin M-WCST scores increase by 15.14 points. With these data, it is possible to affirm that hemoglobin, although it has a positive relationship with the tests, is low.

The BMI and the results obtained in the grades taking into account the R^2 present a very weak positive relationship. But analyzing from the correlation coefficient, they present a low negative relationship. The slope of the regression equation of +81.89 implies that for each unit increase in BMI, grade scores increase 81.89 points.

The BMI and the results obtained in the saber tests, taking into account the R^2, present a very weak positive relationship. But analyzing from the correlation coefficient, they present a low negative relationship. The slope of the regression equation of +39.91 implies that for each unit increase in BMI, test scores on the Saber exams increase by 39.91 points.

Therefore, the BMI with students' grades and the Saber Tests, although negatively related, is low.

Hemoglobin and the results obtained in the grades taking into account the R^2 present a very weak positive relationship. But analyzing from the correlation coefficient, they present a low negative relationship. The slope of the regression equation of +80.04 implies that for every unit increase in hemoglobin, grade scores increase 80.04 points.

Hemoglobin and the results of the Saber Tests, taking into account the R^2, show a very weak positive relationship. But analyzing from the correlation coefficient, they present a low positive relationship. The slope of the regression equation of +31.55 implies that for each unit increase in hemoglobin, Saber Test scores increase by 31.55 points. That is, hemoglobin with students' grades and the Saber Tests, although they have a negative relationship, it is low.

Trying to test the relationship that exists between nutrition and cognitive processes that affect academic performance in adolescent students at CIME, it can be deduced that, although there is a close relationship between these two variables, it cannot be concluded that nutrition has the most direct relationship. There is evidence from the reviewed literature that mentions such a relationship, and what is finally affirmed through this research, is that in addition to the

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relationship between nutrition and academic performance, there may be multiple causes.

It would remain for future research to study in more depth all this complex understanding of what a true learning process implies based on emotional, physical, psychological and environmental conditions in accordance with what the student should be provided to achieve the objectives of his or her integral formation. All this is worthwhile, if applied to the context of the student with a view to contributing in the long term to the quality of life of people.

Acknowledgments

Conflict of Interest

The authors have no conflict of interest related to this publication.

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PEDAGOGY IN GLOBAL CITIZENSHIP AND CIVIC COEXISTENCE. A RESPONSE TO THE CHALLENGES OF GLOBAL HUMAN CONVIVIALITY

Pedagogía en ciudadanía global y coexistencia cívica. Una respuesta a los desafíos de convivialidad humana mundial

Jesus Alfredo Morales Carrero
Universidad de Los Andes, Venezuela (lectoescrituraula@gmail.com) (https://orcid.org/0000-0002-8379-2482)

	ABSTRACT
Keywords: Human coexistence, cultural dialogue, civic virtues, universal values, recognition of diversity.	This research, as a result of a documentary review, proposes a theoretical-conceptual and epistemic approach to the idea of pedagogy for global citizenship as the transformative process capable of configuring peaceful, just, tolerant and inclusive conditions from which to achieve full acceptance and recognition of the sociocultural and ideological particularities that coexist in the world. To do this, fundamental (direct) authors on global citizenship education and complementary (indirect) sources were consulted whose contributions reiterate the need to form a citizen with the civic vocation and the flexibility to interact with a critical sense, as well as with both the ethical and empathetic disposition to welcome diversity without any conditioning that motivates the reinforcement of exclusive, discriminatory and intolerant attitudes. The results indicate that pedagogy for global citizenship constitutes a hopeful possibility to teach universal values, fundamental rights, the guarantees that peoples and cultures enjoy, as well as the parameters of inclusive social justice that calls humanity to the praxis of active solidarity and critical tolerance with those who hold a different belonging; This means generating pedagogical experiences that enhance the development of civic virtues through which to promote the emergence of democratic attitudes, respectful of diversity and committed to full reciprocal recognition. It is concluded that the construction of a better world and the recovery of the social fabric require a pedagogy that motivates fraternal dialogue between cultures and multiple belongings.
	RESUMEN
Palabras clave: Coexistencia humana, diálogo cultural, virtudes cívicas, valores universales, reconocimiento de la diversidad.	Esta investigación como resultado de una revisión documental propone un acercamiento teórico-conceptual y epistémico a la idea de una pedagogía para la ciudadanía global, como el proceso transformador capaz de configurar las condiciones pacíficas, justas, tolerantes e inclusivas a partir de las cuales lograr la aceptación plena y el reconocimiento de las particularidades socioculturales e ideológicas que coexisten en el mundo. Para ello, se consultaron autores (directos) fundamentales sobre la educación en ciudadanía global y fuentes

complementarias (indirectas) cuyas aportaciones reiteran la necesidad de formar un ciudadano con la vocación cívica y la flexibilidad para interactuar con sentido crítico, así como con la disposición tanto ética como empática para acoger la diversidad sin ningún condicionamiento que motive el reforzamiento de actitudes excluyentes, discriminatorias e intolerantes. Los resultados indican que la pedagogía para la ciudadanía global constituye una posibilidad esperanzadora para enseñar valores universales, derechos fundamentales, las garantías de las que gozan los pueblos y culturas, así como los parámetros de la justicia social inclusiva que conmine a la humanidad a la praxis de la solidaridad activa y la tolerancia crítica con el que ostenta una pertenencia diferente; esto supone, generar experiencias pedagógicas que potencien el desarrollo de virtudes cívicas a través de las cuales impulsar el afloramiento de actitudes democráticas, respetuosas de la diversidad y comprometidas con el reconocimiento recíproco pleno. Se concluye, que la edificación de un mundo mejor y la recuperación del tejido social requieren de una pedagogía que motive el diálogo fraterno entre culturas y pertenencias múltiples.

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Introduction

Global citizenship education, seen as a process at the service of encounter, conviviality and human reconciliation, is based on intentional interaction (Barragán *et al*, 2020), which, together with respect for human rights and recognition of diversity, seeks to reduce the gaps of discrimination and xenophobia that have historically threatened the global social system, causing destructive abuses of dignity and moral integrity (Cortina, 2021b; Roca-Jusmet, 2022).

In these terms, the superimposition of human dignity above any socio-cultural conditioning, in an attempt to build a possible future based on a critical awareness of the relevance of weaving bonds of fraternal unity (Berlin, 2022); antidote to which is understood as the catalyzing force of meaningful experiences of coexistence in which injustices are blurred and, instead, deepen the common task of weaving sustainable interconnections that revitalize the commitment to respect for the other, with their belonging and their worldview (Díez, 2024; Loys, 2019).

Thus, living together as a generalized task of the global educational and political agendas has occupied the institutional efforts of all times to consolidate processes associated with the transcendence of the human race through the fulfillment of concrete actions linked to the enhancement of social interactions between cultural groups with diverse belongings. In this sense, fruitful dialogue and the search for opportunities for real encounter have emerged as the links of a new global relationship, which urges humanity to replace individualism with collective actions that guarantee the praxis of a life in community, as the necessary resource to maintain the common heritage of society: the sustainable vindication of human dignity (Morales, 2024b).

This emphasis on reciprocal encounter as part of a new scheme of human coexistence based on inclusive social justice poses the challenge of consolidating intercultural dialogue and respect for multiculturalism, as qualities on the basis of which the conditions for promoting respect for diversity are configured, for pluralisms and worldviews, as requirements for promoting mechanisms focused on safeguarding sociocultural particularities, but also on overcoming the effects of stigmatization and stereotyping that have essentially distanced humanity from the possibilities of reconciliation.

In this sense, global citizenship pedagogy as a process at the service of the full exercise of the capacity for agency (Delors, 2000; Sen, 2000), emerges as a hopeful possibility of creating, strengthening and building bridges of encounter and reconciliation between the diversity of cultures that inhabit the planet; offering for this purpose the formation of a subject whose civic vocation as well as his attachment to the praxis of universal morality will lead him to the use of deep dialogue with the other that, in addition to expanding the possibilities for real encounter, will also motivate the emergence of a critical sense that results in the discovery of similarities between the social, cultural, historical and ideological traits of one's own and those of the rest of the world (Maalouf, 1999).

This implies strengthening planetary attitudes that reiterate the commitment to the coexistence of multiple identities, which is one of the tasks of global educational agendas that call, among other aspects, for the development of attitudes of openness based on critical tolerance as a universal value whose purpose is to motivate coexistence based on the recovery of collective trust, which is understood as the cohesive force of society that, in addition to directing life towards the praxis of individual and positive

freedom, also seeks to guide the relationship processes towards democratic purposes that trace the horizon towards a solid, functional and framed coexistence within the parameters of universal morality (Markus, 2021; Olmedo, 2018).

In these terms, pedagogy for global citizenship entails as its intentionality the formation of a conscious subject as well as the transformation of societies from a warmer and more humanistic approach, in whose bosom co-responsibility with the safeguarding of a dignified and harmonious existence is harbored, in which all, self-perceiving themselves as endowed with common characteristics, manage to build arguments that, based on the capacity of ethical judgment, justify the need to generate a universal amalgam of principles that intensify the civilized procedure, the respect for multiple visions in which to specify similar traits as well as to urge the reciprocal recognition of blurring borders and delineate the common path based on historical, social and cultural references (Morín and Delgado, 2017).

This is justified by the transcendental commitment of education to the formation of the so-called citizen of the world, who adheres to the human commitment to think and perceive oneself in a relationship of interdependence and never separated from the praxis of conviviality framed in the recognition of positive and individual freedom, the safeguarding of personal autonomy and human dignity, as principles that guarantee the full existence of the human race (Nussbaum, 2010). In view of the above, this research aims to establish a theoretical-conceptual and epistemic approach to the idea of a pedagogy for global citizenship, as a result of the articulation of values, principles and virtuous attitudes that derive in transforming processes capable of configuring peaceful, fair, tolerant and inclusive conditions from which to achieve full acceptance and recognition of the sociocultural and ideological particularities that coexist in the world.

Method

This documentary research with a qualitative approach assumed as informant subjects the authors who address the direct, indirect and underlying referents according to which to establish the bases of a conceptualization as well as the tasks of a pedagogy for global citizenship; for this purpose, original texts were consulted (original texts) which, when linked to complementary sources (scientific and specialized journals), contributed to a theorization on the possibilities of coexistence in the future based on a dialogue between diverse belongings.

Content analysis was used as a technique with the purpose of specifying epistemic positions and the practical elements according to which to outline the path towards reciprocal understanding, respect for diversity and recognition based on inclusive social justice, as universal values that revolve around teaching that enhances the full exercise of citizenship in a broad sense as well as active citizenship (Camps and Giner, 2014), as a hopeful alternative with significant implications in the construction of a better world.

As analysis criteria, their direct referents and theoretical proposals associated with inclusion were considered, as well as indirect positions applied to other realities, thus specifying common coexistence possibilities among the authors consulted. With respect to the axiological criterion, an attempt was made to differentiate the values to which each author emphatically devotes special consideration throughout his works. The criterion of complementarity was used to specify theoretical-conceptual and epistemic connections resulting from the contrast between main texts and secondary sources, in an attempt to establish a dialogue of ideas that would make it possible to specify the requirements for the construction of a possible world based on justice, peace, equity, freedom and the common good.

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This made it possible to establish coinciding patterns among authors with regard to the following dimensions: effective inclusion, operationalization of actions, institutional commitment and synergic safeguarding of dignity and full exercise of individual freedoms; tangential ideas from which to structure actions founded on respect for pluridiversity that results in the creation of conditions associated with social justice, with the achievement of equitable possibilities in which each subject attending the educational institution manages to express their positions, their ways of life, their worldviews and socio-cultural and historical belongings without any type of coercion that limits their autonomous performance.

Results

Living together and learning to build democratic and inclusive ties of cohabitation are required in the global political and educational agendas as purposes closely associated with the construction of a possible future (Cely-Fuentes, 2021; Morales, 2024c); in which citizens in formation, aware of their leading role in the cultivation of virtuous and civic behavior, assume the challenge of participating not only in the affairs of all, but also in the common task of strengthening the sensitive and deep understanding from which the management of divergences derives, in an attempt to reach the dynamic state of reciprocal understanding on which the recovery of the social fabric depends (Cortina, 2021a).

Thus, conveying dignified and functional human coexistence is one of the challenges of education in general, whose purposes include the need to train citizens with the attitudinal disposition to relate to third parties whose diverse and plural membership calls for inclusive, tolerant and non-discriminatory treatment. This emphasis on positive conviviality as an objective on which the transcendence of the human race depends (Morín, 2015), has reiterated the commitment to the praxis of universal values associated with fraternity, democracy and social justice, which are assumed as the threads through which to weave functional relationship processes.

In these conditions, pedagogy for the exercise of global citizenship proposes the construction of the foundations of an inclusive life, in which all human beings, aware of their planetary condition, reach an enriching dialogue that not only recognizes the need to overcome individualisms, fundamentalisms and extreme positions, but the consolidation of the behavioral, ethical and attitudinal repertoire to operate from the civism that makes possible the opening to the multiple belongings from the self-criticism that gives rise to the overcoming of discriminations in their pluridiverse ways of manifesting themselves (Savater, 2000).

In this sense, the promotion of the ability to coexist as a process that enhances the human encounter framed in respect and critical solidarity is assumed as the revitalizing force of the social fabric, to which the citizen can adhere from the commitment to intelligently manage antagonisms, controversies and socio-historical confrontations that have been attributed both the reinforcement of prejudices and the transcendence of human estrangement.

In these terms, pedagogy for global citizenship reiterates the need to build and rebuild a positive world climate that, together with sustainable peace, gives way to empathetic and sustainable interaction experiences (Sen, 2023), in whose content the building of the shared vision required to weave the foundations of the so-called coexistence based on permanent dignity is considered as a categorical imperative (Morales, 2024a).

This constitutes a generalized invitation to safeguard moral integrity and recognition free of prejudice, as requirements to consolidate schemes of coexistence that vindicate

the sense of community (Cortina, 2021b); in which all citizens, regardless of their belonging, their worldviews and pluralisms, can reach bridges of recognition that, together with fruitful dialogue, make possible the construction of new possibilities to coexist from the praxis of pacifism and nonviolence (Cely-Fuentes, 2021; Torres, Torres and Miranda, 2021).

This is assumed as a renovating movement focused on settling differences in the plane of critical-symmetrical dialogue, in which the subjects in formation achieve a deep understanding of the socio-cultural, historical, and ideological particularities that permeate the humanity of the other in an attempt to discover common spaces in which divergences are blurred giving way to the ideals of conviviality that entail, among others, reciprocal respect, reconciliation based on acceptance as a common value capable of allowing positive concessions for all as well as motivating the sense of both interdependence and complementarity that must prevail in any process of human cohesion.

This vocation towards the recognition of the other as a subject of rights who is entitled to a series of universal guarantees, is understood as one of the tasks of the pedagogy for global citizenship that involves the resizing of cohabitation conditions, which is based on the development of community convictions as a way to promote attitudinal adjustments associated with the management of totalitarian, intransigent and intolerant positions that are attributed with the permanence of hostility with harmful repercussions in various areas of the planet.

From Maalouf's (1999) perspective, orienting humanity towards civic action suggests making society a co-participant in the spirit of tolerance that broadens the possibilities of coexistence in a climate without barriers limiting personal autonomy and permeated by openness to mutual enrichment derived from interaction with universal culture, with other worldviews and pluralisms, as elements that together with enriching the worldview reiterate the unavoidable commitment to safeguarding what makes us particular as human beings.

This, as part of the tasks of global citizenship pedagogy, implies the strengthening of the possibilities of understanding each other better, but it also urges the formation of a co-responsible subject with the civilized procedure derived both from the knowledge of universal culture and from the implicit links that exist between groups. This procedure as an ideal equally shared by education for the exercise of full coexistence, involves as an intentionality the transformation of the human being (Maturana, 1991), in whom to motivate the global demand to adapt to changes without implying to renounce to its socio-historical and cultural load, but open to rethink its position towards the other in an attempt to avoid denial and, consequently, to strengthen reciprocal recognition.

From Morín's (2015) perspective, the above is but part of the tasks of education in a broad sense, which refers to the active role of creating the opportune conditions for the subject to manage "to face vital problems such as those of terror, illusion, partiality, human understanding, uncertainties that every existence encounters" (p. 9). This emphasis on building a possible world also involves the development of a profound planetary vocation, in which the central axis of its operations revolves around civic, ethical and moral conduct that favors the creation of a harmonious and supportive environment.

In other words, it is about strengthening in the subject being formed the commitment to respect identities as social constructions that allow not only the manifestation of particular ways of life that because they are framed within human diversity enjoy the universal protection established in human rights instruments (Ferrajoli, 2016); a

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condition that places humanity in the plane of inclusive, egalitarian and fair treatment as parameters that due to their axiological implications give rise to the suppression of extremist and irrational positions.

In response to these requirements, global citizenship pedagogy proposes as part of its strategies to strengthen dignified coexistence through the operationalization of reasoning and reflexivity, as cognitive activities that, together with broadening planetary awareness, also pave the way for the creation of coalitions in which individualistic interests are converted into collective purposes; which is a significant contribution to the vindication of community life as well as its main ideals: positive freedom and social justice (Morales, 2024c).

Hence, the emphasis on promoting a new culture based on the willingness to accept the existence of the other as a subject with the capacity of agency, that is, with the enjoyment of a series of guarantees that demand respect for their identity, for the manifestation of the particularisms and cosmovisions of each nationality, as conditions on which to deploy the goodness of reasoning to motivate in those who are formed the deep approach capable of weaving deep bonds that shape the adherence to life in a broad community, in which all, perceiving themselves as part of a whole, manage to promote collective aspirations that result in the integral welfare and quality of life (Nussbaum and Sen, 2004).

In view of the above, pedagogy for the full exercise of global citizenship involves efforts focused on revitalizing human existence through the resizing of the sense of community, which seeks the mobilization of capacities to agree on guidelines for coexistence that reiterate the commitment to the construction of a climate of trust and civility, in which the subject that is formed feels genuinely included in the universal family called the human race (Morín, 2015).

This means teaching for the achievement of an existence mediated by mutual respect as the universal value on which depends the realization of functional approaches that make possible the fulfillment of two aspects necessary for positive global coexistence; on the one hand, the freedom for every subject to be able to reaffirm their differences and express their particular positions on the world without restrictions and, on the other hand, to strengthen the planetary conscience that makes possible the construction of a common destiny focused on strengthening the sense of human community, in which each subject becomes a repository of global references that as guiding principles of coexistence make functional links a horizontal possibility for true encounter.

According to Nussbaum (2010), this need to promote new schemes of positive relationship between subjects with diverse belongings implies a challenge that must involve some fundamental requirements, among which is the adherence of the subject to permanent reflection on public affairs with the intention of motivating coexistence mediated by debate, the argumentation of reasons and possibilities of understanding; from this derives the willingness to recognize the other as a citizen with diverse belongings equally esteemed within the guarantees established in universal juridical devices. From this derives "the ability to take an interest in the lives of others, to understand the implications of each policy for the opportunities and experiences of other citizens and people living in other nations" (p. 49).

From this perspective, ensuring that humanity shares the minimums of a universal, broad and planetary culture (Maalouf, 1999), constitutes an invitation to the intelligent management of our differences (Cortina, 2013) as the starting point for enriching the conditions of reciprocal acceptance as well as the construction of a human climate that favors not only respect for fundamental rights but also the configuration of the

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foundations of a new human dignity, in which fair, equitable treatment based on the common good; hence the reiterative position of Maalouf (1999), in proposing that this inclusive climate seeks "to respect someone, to respect his history, which refers to considering that he belongs to the same human genus, and not to a different human genus, to a second-class human genus" (p. 63). 63).

To procure this level of acceptance, positive acceptance and tolerance of differences refers to the configuration of a teaching process based on the full recognition of human rights, as categorical imperatives on the basis of which to weave new behaviors both respectful of human dignity and reiterative with the commitment to fight against discriminatory attitudes that make coexistence incompatible with full human dignity; in the face of which the strategic antidote supposes adhering the subject in formation to the task of involving the other as a fellow citizen with full rights to coexist, to operate in freedom and to proceed with both autonomy and responsibility.

In this sense, pedagogy for global citizenship implies a renovating movement focused on promoting the recovery of the social fabric through the praxis of universal values, through which to foster meaningful dialogue among multiple belongings in an attempt to confront global conflict and the countless sociocultural tensions that threaten to eradicate the particularities that identify certain groups; this dialogue as part of the interaction under parity conditions is understood as a strategy at the service of the possibility of generating coalitions, of establishing agreements and of granting predominance to the civilized task, as requirements to model guidelines that orient individual actions towards rational, conscious and open purposes to safeguard diversity as the common heritage of humanity (Bautista, 2013; Cortina, 2009).

In this regard, Maalouf (1999) in reference to reciprocity as a guiding principle of community life, indicates that adhering the subject in formation to coexistence in a world saturated with dynamic identities, composed and nuanced by common and particular traits, implies strengthening the sense of openness to a deep understanding of the most prominent cultures that make up the planet, with the intention of establishing links of similarity that allow rapprochement, but also the precision of aspects that singularize certain groupings, as conditions from which to build mechanisms from which it is possible to resize relations at the global level.

This flexible attitude towards identities also constitutes the revitalizing force of positive curiosity and meaningful discovery, as processes that, because they are rooted in the cognitive dimension, lead to the suppression of racial and ethnic prejudices; but also as mental operations that, due to their relationship with the full acceptance of the other, allow those who hold a different belonging to represent with special sensitivity the different cultures, which they can recognize without reservations, without resentment, but rather, from the commitment to safeguard their participation in contexts different from those of origin (Camps, 2011; Sen, 2001).

In these terms, pedagogy for global citizenship as a sensitizing process, poses as a challenge the enlargement of the individual's radius of action through the widening of his democratic attitudinal repertoire, as the condition that gives way to the real possibility of forging active listening and deep dialogue that allows subjects with diverse belongings to dive into the personal life of the other, in their socio-historical, cultural, ideological and identity traits, in which to specify shared elements that blur the image both distancing and negative, giving both parties the opportunity to strengthen bonds of trust that allow moving forward into the future free of prejudice.

This hopeful process for the human family constitutes a revitalizing alternative for the possibilities of dignified coexistence in the face of the dark moments that life is going

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through in other contexts of the world, since it involves efforts to modify radical, fundamentalist and extremist positions; thus strengthening the shared sensation of replacing exclusionary individualism and discriminations responsible for human humiliation with empathic and altruistic attitudes whose disposition to accept the cultural and socio-historical legacy of the other makes possible not only the configuration of rules of the game associated with coexistence, but also the renunciation of the dysfunctions generated by the inherited unequal treatment, to which hostile and violent ways of proceeding, among other aspects, are attributed.

Therefore, pedagogy for global citizenship as a process of promoting the teaching of intercultural dialogue and the manifestation of multiculturalism in conditions of full freedom, involves the expansion of inclusive awareness as a requirement in function of which to adhere to the subject that is formed to the critical sense as well as to the co-responsibility of recognizing ways of life and ancestral practices that, because they represent part of the common heritage of humanity, require the committed exercise of critical tolerance, effective social inclusion framed in the paradigm of sustainable cultural transcendence, as well as the attitudinal disposition to learn patterns of solidary relationships that reinforce the categorical imperative of building a world for all.

In these conditions, living together as an axis that transversalizes the search for a climate of peace and full encounter between diverse belongings, supposes the teaching of reflective thinking about the benefits of interacting socioculturally, strengthening bonds of functional coexistence and deploying both behavioral and attitudinal disposition in favor of making the world a space for the full manifestation of personal autonomy; but also, to resize the feeling of belonging to a global society interwoven by universal values, in which everyone orients their actions towards the establishment of connections between the local and global dimensions.

This implicitly refers to the participation of edifying dialogue as the social competence in function of which to build societies whose peaceful vocation and collective conviction allow the emergence of positions open to inclusion, positive involvement as well as conviviality that seeks to dignify humanity through the substantiation of the socio-cultural conditions necessary to build a common future, free of discrimination, hostilities and adhering to the praxis of universal morality.

What has been said indicates that pedagogy for global citizenship constitutes the possibility of recovering the conviction of living well, in respect for both the human condition and its permanent dignification, which implies developing the subject's sensitivity to the superimposition of preferences and the hierarchization of personal objectives, which should be nuanced by the collective conviction of promoting a coexistence based on the pursuit of happiness as well as the state of plenitude in which the emergence of its potential is possible, but also the deployment of attitudes related to the overcoming of conflict and, instead, to the realization of tranquility, harmonious coexistence and the emphatic struggle for the protection of the integrity of both oneself and the other.

In this sense, living together in dignifying conditions implies establishing relationships anchored in universal morality and in the cultivation of public virtues in order to build a new citizen, whose approach to life is assisted by the need to practice the common good, a *sine qua non* requirement on which depends the revitalization of the collective interest and the reciprocal disposition to nurture the spirit of friendship, as a sufficient condition to act in solidarity until blurring differences and building a shared vision of conviviality in a broad sense.

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This construction of a shared vision is closely associated with the definition of ways of life based on the idea of global community, in which all subjects, assuming coexistence as a system interwoven by rights, guarantees and obligations, expand the possibility of overcoming divisive boundaries by common bonds from which to motivate self-perception around the feeling of belonging to a broader society, in which interests, worldviews and pluralisms can be integrated as elements from which it is possible to articulate both positive and functional relationships that interconnect differences in a meaningful dialogue leading to deep understanding.

In these terms, it is possible to see as the underlying purpose of pedagogy for global citizenship the emphatic defense of the free self-determination of peoples that involves respect for the inherent dimensions of full life, among which are: the preservation of democratic good and inclusive social justice, participation in public affairs and the full exercise of sovereignty, as elements that are assumed to be inherent to coexistence based on the autonomy and positive freedom of multiple cultures with respect to the full manifestation of their unrestricted belonging.

This conscious procedure based on empathy is the result of the formation of a sentimental subject (Bloom, 2018), capable of assuming as a mission the precision of similarities and the strengthening of the interdependence required by humanity in its challenge to transcend towards a critical conviviality in solidarity, in which everyone, displaying their willingness to welcome differences, manages differences as generating qualities of fraternal encounter (Delors, 1999; Morin, 1999; Sen, 2021), which, based on interdependence, makes it possible to confront individualism as a socio-historical burden on which the configuration of a more humane world depends, aware of preserving respect for singularities above any human conditioning, thus reinforcing the need to move towards the pursuit of happiness and coexistence framed in inclusive social justice (Cortina, 2013).

Where Are We Going and What Can We Do from the Perspective of Global Citizenship Pedagogy?

This section presents some approaches related to the possible scenarios and requirements that education in general and global citizenship pedagogy specifically should assume in order to achieve the goals of inclusive social justice, as the universal value that seeks to strengthen the civic vocation and the commitment of humanity in the task of building a better world, in which differences and individualisms can be blurred in an attempt to transcend towards a new scheme of relationships that will encourage us to deploy common and synergetic efforts that motivate autonomous performance as well as interdependence between subjects with opposing belongings (Camps, 1999; Morín, 1999).

According to Cortina (2013), overcoming humanity's disaffection with civic and community life, constitute the vertexes of a global initiative that should seek the encounter between the cultures of the world, with the purpose of achieving a sensitive reflective dialogue that allows those who are being formed to adhere to the commitment to face from the collective synergic action the recovery of confidence in the democratic-participative schemes of coexistence, among other aspects, to deploy the ethical attitudinal potential, the civic and public virtues, as well as the active procedure on which depends the consolidation of the so-called project of common life of humanity: to live together peacefully and in solidarity without transgressing the integrity of the other.

This constitutes efforts associated with the unification of global human wills around the hope of building a better world, in which individual life reaches its free and

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autonomous performance within the framework of co-responsibility, which involves the common hope of achieving a functional conviviality in which everyone aware of the existence of the other deploys their willingness to adhere to the global project of inclusion, in which everyone finding their place on the planet also manages to raise the collective enthusiasm in order to cultivate the recognition of unity amidst diversity (Morin, 2011).

Further on, Morín (2015) proposes that living in a world permeated by pluralisms and identities that particularize each human group requires the insertion of the subject in meaningful experiences in which he/she can learn about the positive management of belonging as features that configure a singular scheme of fraternal acceptance that assumes the encounter as a possibility to strengthen the bonds of coexistence; hence, global citizenship pedagogy reiterates the commitment to the formation of a subject capable of understanding that "to live is to live as an individual facing the problems of his personal life, it is to live as a citizen of his nation, it is to live also in his belonging to the human" p. 15).

In this sense, pedagogy for global citizenship should bring humanity closer to the possibilities of full realization derived from the positive interaction that encourages everyone to a common life based on the fulfillment of both social and moral norms in which underlies as intentionality the defense of human dignity; as a universal task that demands the praxis of a coexistence based on the exercise of individual freedoms as well as the fundamental rights in which to specify guarantees of human transcendence.

In these terms, the struggle for an education that seeks the recognition of human dignity above any social, historical and cultural conditioning, implies the reiterative emphasis on forming a citizen committed to the commitment of valuing human worth as a task that involves the "recognition of the dignity of each person, regardless of what he or she is or does in life" (Camps, 1999, p. 63). This refers to the estimation of the human condition as a starting point to generate consciously inclusive relationships, in which the sense of positive freedom is privileged as well as the disposition to specify the spaces and situations in which it needs to be practiced in order to avoid the violation of the well-being of others.

Camps (1999) then proposes that the scope of sustainable human coexistence begins with the suppression of individualism through the substitution of personal interests by collective purposes interwoven by altruism and empathic understanding, as strategic antidotes according to which to resize the real possibilities of making coexistence compatible through the transmission of universal values, as common guidelines from which it is possible to eradicate inhuman and uncivilized attitudes contrary to full functional coexistence.

Facing these global challenges implies reinforcing the acceptance of dissent as a mechanism to prove the effectiveness of critical tolerance and active solidarity, as guiding principles of a democratic, pluralistic and open to the praxis of pacifism life (Delors, 2000; Morín, 2015; Savater, 2014); these tasks seek to raise human trust as the value from which not only to revitalize social bonds but also the rooted adherence to enduring ideals that give transcendence to functional human coexistence; this requires from the educational systems the conviction to motivate the reflective capacity both individual and collective, as the cognitive process from which it is possible to overcome unfounded beliefs and prejudices that do not give way to fraternal encounter (Morales, 2023).

From this perspective, strengthening the axiological dimension of humanity as a resource at the service of coexistence in a broad sense implies reinforcing moral judgment as the attitude that calls for "believing in justice, in solidarity, in mutual respect, which means, in fact, desiring more justice, more solidarity or more respect...this requires the

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discovery of the benefits of showing signs of solidarity, order, civility" (Camps, 1999, p. 69).

Galtung (1998), for his part, proposes that thinking of peace as a task of all times constitutes one of the axes of lifelong education, since it involves real possibilities associated with the management of human conflicts, a process that implies pedagogical efforts associated with the adoption of meaningful dialogue from which to deepen the establishment of agreements on coexistence in the future; these concessions as a result of civic training seek to resize the opportunities for encounter and reconciliation between cultures with dissimilar belongings, whose identity particularities and worldviews require a resignification of life in society, as the means through which to specify the path towards positive peace as the universal value that involves a deep understanding of the interdependence that must mediate in social relations.

The above shows pedagogy for global citizenship as the process that urges the configuration of a comprehensive climate, in which everyone aware of the need to operate within the parameters of social justice become agents whose capacity for action allows them to build a society open to effective inclusion, to participation on equal terms and adhering to the need to practice equity as a resource at the service of the realization of integrative actions as well as cooperation, requirements from which it is possible to promote the full development of the potential of every human being.

Therefore, establishing the parameters of a democracy that guarantees coexistence requires reiterating the universal commitment to the recognition of human rights as the means by which it is possible to claim the exercise of personal autonomy (Quiceno, Betancur and Rojas, 2020); but also, as the possibility to achieve the transformation of society towards new schemes of peaceful and harmonious relationships that together with substantiating the global requirements of cohesion and unity in diversity, also promote the emergence of the collective vocation to fight against socio-historical discriminations and exclusions that have plunged humanity into deep decadence.

In this sense, pedagogy for global citizenship, seen as a pending subject in all educational systems, stands as the revitalizing force of human bonds, as well as the neutralizing process of the systematic humiliations that have permeated to a greater or lesser extent the existence of certain societies, in which to promote the construction of spaces for dialogue leading to the establishment of common standards that reiterate the shared mission of humanity: to learn to coexist together, to participate in the affairs of all and to deploy cooperative attitudes that encourage both deep interaction and exchange between divergent worldviews (Delors, 2000).

In these terms, learning to live together as a global challenge of all times, entails as an intentionality the eradication of the self-destructive potential that permeates some societies, through the revitalization of peaceful encounters and the praxis of non-violence as antidotes that seek, among other aspects, the overcoming of rivalries (Morín, 1999) and the management of tensions through the resignification of conflict, which can be understood as a way to lay the foundations of new agreements around the construction of common spaces, in which bonds such as friendship and trust are erected as threads on which to weave plural and democratic societies (Sen, 2021).

In view of the above, the pedagogy for global citizenship seeks to privilege the adoption of the spirit of reconciliation as the articulating axis of solid links that allow those who hold different belongings to participate in public affairs under equal conditions and without restrictions that violate their fundamental rights (Bolívar n.d.; Camps, 2001). In the face of this encouraging panorama, it is considered indispensable to build a society whose ethical and moral pillars are based on the need to progressively include the other,

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fulfilling a series of requirements: firstly, to foster the gradual discovery of the beliefs, preferences and interests of those with a different origin; secondly, to guarantee the establishment of rules that vindicate the dignified existence above any human conditioning and, finally, to guarantee the offer of participation mechanisms framed within inclusive social justice, thus ensuring the prevention of future conflicts as a result of exclusion (Bonomo, Manberti and Miller, 2010; Morales, 2024b; Sen, 2010).

In view of the above, the search for a life that guarantees human transcendence implies the emphasis on the formation of the new citizen of the world, whose reflective capacity and commitment to reconciliation involves him/her in the construction of a society focused on walking along the paths of universal morality (Cortina, 2013), which calls for the praxis of a full life, free of inequalities and affects the receptivity of multiple belongings as an opportunity to make room for the participation of the other without limitations and instead, within the framework of a virtuous existence in which mutual respect and democratic coexistence prevail.

Therefore, leading to peaceful existence as the means to achieve future understanding requires a new ethical procedure, as a fundamental attitude to weave the so-called recovery of the social fabric, a process from which it is possible to consolidate covenants of citizen relationships that insist on community life with attachment to global principles that, as part of the common heritage of humanity, enhance the autonomous human performance of a subject whose willingness to build the functional scheme of coexistence allows the opening to real possibilities of inclusion, whose basis is none other than the interest of all above individualism (Quiceno, Betancur and Rojas, 2020).

This persistent concern for the transformation of the human being is a way to consolidate integral wellbeing and quality of life, as generalized concerns that global citizenship pedagogy considers the cornerstones of the realization of a free world, based on social justice and the realization of human potential as a categorical imperative. In the words of Cortina (2013), creating the conditions for a positive conviviality requires reinforcing the formation of *homo reciprocans*, as the condition to motivate "the cooperative character of people. In this sense, altruism, which implies for the individual to invest part of his resources in favoring the adaptation of another" (p. 81).

In view of the above, pedagogy for global citizenship involves then the commitment to the realization of functional and sustainable human bonds, which enable the individual's ability to establish cohabitation pacts mediated by the mutual recognition of the need to live according to moral and ethical standards that, as part of the personal and social commitment, substantiate the sense of world community; thus allowing transcendence towards just societies, adhering to the praxis of a good life in which the exercise of basic freedoms guarantees participation in public affairs, in the co-construction of paths of peace and sensitive acceptance that legitimizes the transcendence of the democratic values necessary to coexist in the future (Morales, 2023).

In short, bringing humanity closer to empathetic understanding and active tolerance as tasks closely linked to the exercise of global citizenship requires educating present and future generations about the commitment to cultivate the self through their attitudinal adherence to universal morality, which is assumed as the articulation of universal values and principles that, oriented towards the enhancement of peaceful coexistence, allow us to vindicate the tasks of fraternal reconciliation as a common project of humanity.

Conclusions

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Promoting the capacity to adapt to the change that the world in general is experiencing due to its recurrent dynamism, constitutes one of the core challenges faced by educational systems at a global level, since it implies the need to adjust the attitudinal and moral disposition of those who are being educated to the requirements of a society that urgently demands greater flexibility to accept, to accept, recognize and welcome with a critical sense the diverse belongings and multiple identities, in an attempt to reinforce the possibilities to learn to live together practicing conviviality from the mutual civic procedure that together with the conviction of community allow the transcendence of the human family.

In this sense, a pedagogy for the full exercise of global citizenship involves strengthening humanity's commitment to the creation of conditions of inclusion, critical tolerance and social justice, in which all individuals, aware of the importance of safeguarding dignity as a universal value, unite efforts to make individual and collective freedoms compatible, in an attempt to promote transcendental changes that strengthen the good life as well as the right to coexist without restrictions associated with the manifestation of personal autonomy.

This refers to a life free of discrimination and associated with the praxis of active respect, which urges humanity to overcome socio-historical, ideological and cultural burdens through attitudinal adherence to fundamental rights, as tangential principles from which it is possible to promote a civic, dignified and honorable coexistence, in which the common axis is the turning of the vision towards the construction of a common world; this means to form citizens willing to dialogue with diverse ways of life, with contradictions and adverse positions until achieving the enrichment of the possibilities to reach a consensus on the possibilities of positive relationships as a requirement to eradicate attitudes that threaten to eradicate both pluralisms and the most diverse cultures.

In these terms, a pedagogy for global citizenship constitutes a way out of the difficulties of world coexistence, by offering the opportunity for the subject being formed to gain access to parameters inherent to universal culture through which to define and resize the possibilities for identities and worldviews to interact on the level of reciprocal respect. Hence, the emphasis on the construction of learning experiences that enrich conviviality, through which to expand opportunities to freely express the diversity of opinions as a civic virtue that, based on a critical spirit, seeks to generate in future generations a commitment to the vindication of equality, social justice and the common good, links on which to sustain the inclusive coexistence demanded by the global society.

This suggests educational actions around the strengthening of attitudes associated with the common interest, which in addition to substantiate the civic repertoire also motivates in the citizen the commitment to coexistence, with the use of dialogue between belongings, worldviews and diverse identities in order to cultivate both habits and virtues that promote the configuration of a more humane world, whose society is interwoven by the common purpose of preserving dignity as a tangential value on which depends the overcoming of socio-historical burdens such as: discrimination, exclusion, intolerance and the violation of the self-determination of minorities.

In synthesis, educating world citizens as the axis of an education with global relevance implies fostering an attitudinal disposition, both ethical and moral, to overcome the gaps that distance humanity, in an attempt to achieve unity in the midst of diversity, which will become the cohesive force of a new scheme of coexistence interwoven by intercultural dialogue of multinational scope, allowing the creation of solid, functional and

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transcendental agreements, in order to promote more sensitive, more humane and warmer interactions.

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Digital competences in secondary school teachers: Proficiency levels and training needs

Competencias digitales en docentes de educación secundaria: Niveles de dominio y necesidades formativas

Anny Acosta Fernandez
International Iberoamerican University, México (anny.acosta@doctorado.unib.org) (HTTPS://ORCID.ORG/0009-0006-4701-9405)
José Hidalgo Navarrete
International Iberoamerican University, México (josehidalgonavarrete70@gmail.com) (https://orcid.org/0000-0002-2721-5007)

	ABSTRACT
Keywords: Digital Competence Teaching CDD, levels of proficiency, training needs	Introduction: Nowadays, the incorporation of technology in the educational field has revolutionized teaching, demanding that teachers develop digital skills. These skills go beyond the simple use of technological tools, since they require their effective implementation in teaching processes to promote student participation. Precisely, this article aims to analyze the digital competencies of secondary education teachers, covering levels of proficiency and training needs. Methodology: This is cross-sectional descriptive research, with a qualitative approach. It is based on the application of the Digital Teaching Competencies (CDD) instrument, designed and validated by Tourón and collaborators. Created under the profile of active methodologies. The participants were 62 teachers from a public school. The sample 34 teachers. Sample inclusion criterion, teachers who work directly in the classroom. Results: The analysis reveals that the surveyed teachers show a high level of knowledge in digital skills, but their practical application is lower, according to the classification of Tourón et al. Discussion: It is recommended to offer specific training programs to improve the advanced use of technological tools and their pedagogical integration, in order to raise the quality of teaching in digital environments.
	RESUMEN
Palabras clave: Competencia Digital Docente CDD, niveles de dominio, necesidades formativas	Introducción: En la actualidad la incorporación de la tecnología en el ámbito educativo ha revolucionado la enseñanza, demandando que los docentes desarrollen habilidades digitales. Estas habilidades van más allá del simple uso de herramientas tecnológicas, ya que requieren su implementación efectiva en los procesos de enseñanza para promover una participación por parte de los estudiantes. Precisamente, este artículo tiene la finalidad de analizar las competencias digitales en los docentes de educación secundaria, abarcando niveles de dominio y necesidades de formación. Metodología: Es una investigación descriptiva transversal, con enfoque cualitativo. Se parte de la aplicación del instrumento Competencias Digitales Docentes (CDD), diseñado y

validado por Tourón y colaboradores. Creado bajo el perfil de metodologías activas. Los participantes 62 docentes de un centro educativo público. La muestra 34 docentes. Criterio de inclusión muestral, docentes que trabajan directo en aula. Resultados: El análisis revela que los docentes encuestados muestran un alto nivel de conocimiento en competencias digitales, pero su aplicación práctica es inferior, según la clasificación de Tourón y colaboradores. Discusión: Se recomienda ofrecer programas de formación específicos para mejorar el uso avanzado de herramientas tecnológicas y su integración pedagógica, con el fin de elevar la calidad de la enseñanza en entornos digitales.

Introduction

In the 21st century, the integration of technology in education has significantly transformed teaching, requiring teachers to acquire digital skills. These competencies not only imply the use of technological tools, but also their effective integration in the educational processes, encouraging the active participation of students (Cabero Almenara & Palacios Rodríguez, 2020).

The article discusses the importance of digital competencies, their structure, levels of mastery and the need for continuous training among teachers. In addition, it analyzes how Information and Communication Technologies (ICT) are essential in education, highlighting policies of the Ministry of Education of the Dominican Republic that promote their use in the classroom.

Digital teaching competence is related to the use of ICT to improve teaching, adapting to the needs of students (Digital Competence Framework for Educators (DigCompEdu), 2020).

Several studies highlight the growing interest in Digital Teaching Competence (DTC), particularly in Spain and Mexico, with a notable increase in the number of studies in recent years. Collaboration among authors is significant, although its impact and dissemination varies. Most studies focus on the development of teachers' digital skills and the use of technological tools to improve teaching. The pandemic of COVID-19 has accelerated the need to strengthen the CDD due to the rise of online learning (Sánchez-Castellanos et al., 2024; Granados Maguiño et al., 2020).

It is important to highlight that Digital Teaching Competence improves learning, increasing academic performance, knowledge retention and student motivation. Examples include the use of online learning platforms, interactive applications and digital communication tools to foster collaboration between students and teachers (Cabero Almenara & Palacios Rodríguez, 2020; Carvalho et al., 2019; *Digital Competence Framework for Educators (DigCompEdu)*, 2020; Jiménez-Hernández et al., 2021; Larrea, 2021; Lores Gómez et al., 2019; Martínez et al., 2023; V. A. Pérez & Velasquez, 2024; Rodríguez-Jiménez et al., 2022).

Digital Competence in Education (DCE) refers to the pedagogical use of ICT in an educational context. It involves several aspects, among them: a) technological knowledge, which implies understanding and updating educational tools and platforms; b) technical skills, necessary to operate and solve problems in digital environments and to create multimedia content; c) digital pedagogical competence, focused on integrating technology in a way that is aligned with educational objectives; d) digital communication competence, which facilitates effective online interaction and collaboration between teachers and students.(Cabero Almenara & Palacios Rodríguez, 2020; Christine Redecker, 2020; *Digital Competence Framework for Educators (DigCompEdu)*, 2020; J. A. V. Pérez & Ortíz, 2020; Tourón, 2018; UNESCO, 2022).

Also, recent studies show that while some secondary school teachers perceive themselves as having a high level of digital competence, others require additional training, especially in methodological aspects (Pérez and Ortíz, 2020 ;Arévalo Chávez et al., 2020; Verdú-Pina et al., 2024).

This article also explores the benefits and challenges of ICT integration in the classroom, highlighting the need to bridge the digital divide and provide ongoing training so that teachers can use technology effectively.

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The key questions of the study focus on identifying the current digital competencies of teachers, their levels of mastery and training needs in a secondary school in San Francisco de Macorís, Dominican Republic.

Levels of proficiency, the United Nations Educational, Scientific and Cultural Organization defines the following levels. Basic: elementary use of technology for simple classroom tasks. Intermediate: integration of digital resources to support learning. Advanced: solid and adapted use of technologies, fostering creativity and interaction. Innovative: pedagogical transformation through the innovative use of technology (UNESCO, 2018).

Training Needs: gaps in knowledge, skills or competencies that need to be addressed to improve educational or professional performance (UNESCO, 2018).

Digital Teaching Competence CDD: is the relation of the use of ICT from a pedagogical didactic perspective in an educational context (Cabero Almenara & Palacios Rodríguez, 2020).

In the current educational context, digital competencies have become essential for the effective performance of teachers. Teaching methodologies require an increasing integration of digital tools to enhance the educational experience   (Cabero Almenara & Palacios Rodríguez, 2020, 2020; Christine Redecker, 2020; INTEF, 2017; Tourón, 2018).

The Ministry of Education of the Dominican Republic has incorporated ICTs as key tools for learning and has established policies for the development of scientific and technological competencies in education. These policies focus on two main components: first, the exposure of natural and social scientific manifestations; and second, the application, communication and understanding of scientific and technological approaches, models, principles, laws, theories and theories (MINERD, 2023).

However, many teachers lack the necessary skills to effectively use these tools in their pedagogical practice (González, 2023; J. A. V. Pérez & Ortíz, 2020; Rodríguez-Jiménez et al., 2022).

This study aims to analyze the digital competencies of secondary school teachers, identifying their levels of mastery and the areas in which they need training. The results of this study will allow a better understanding of the training needs in digital competence and will help to design more appropriate training programs.

Method

Methodology

This study used a descriptive and analytical research methodology with a qualitative approach. The objective was to analyze the digital competencies of teachers at a secondary school in Educational District 07/05, San Francisco de Macorís, Dominican Republic, in order to identify their levels of mastery and training needs.

The main instrument was a questionnaire previously validated by Tourón and collaborators, based on a scale of values that quantifies the variables associated with digital competencies (Tourón et al., 2018)based on a scale of values that quantifies the variables associated with digital competencies.

The research design was descriptive cross-sectional, which made it possible to analyze the level of competencies and the training needs of teachers at a single point in time. (Hernández Sampieri et al., 2014).

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The procedure followed an inductive-deductive approach, starting with the collection of specific data and then generalizing conclusions based on established digital competence models, such as the European Framework for Digital Competence in Education (DigCompEdu) (Cabero Almenara & Palacios Rodríguez, 2020; Tourón et al., 2018; UNESCO, 2018, 2022).

Route and Procedures

1. Initial Visit: A courtesy visit was made to the Liceo Ercilia Pepín to socialize with the directors and deliver the letter of district approval to carry out the data collection.
2. Presentation of the Project: The research project was presented to the Educational Center and focus groups were formed with teachers to explore their digital competencies.
3. In-depth interviews: In-depth interviews were conducted with teachers to obtain detailed information about their level of digital competencies.
4. Online Panel: An online panel was created with direct access to the digital competencies questionnaire (CDD), generating a specific link for the group.
5. Application of the Questionnaire: The validated questionnaire of Tourón et al. (2018) to teachers through the online platform.
6. Data analysis: The data collected were analyzed and tabulated, contrasting the results with the referential framework of teachers' digital competencies.
7. Presentation of Results: Finally, the findings were presented and analyzed based on the pre-established models of digital competencies.

Participants

The study included a population of 62 teachers, 34 of whom were selected for the final sample under the criterion of working directly in the classroom. The remaining 28 teachers, who performed other academic functions, were excluded from the study. No specific profiles were established for the selected teachers.

Instrument

We used the questionnaire validated by Tourón et al. (2018), which consists of 54 questions designed to measure the knowledge and use of digital tools in the teaching environment. Each item is evaluated on a scale of 1 to 7, where 1 represents the lowest degree of knowledge or use and 7 the highest. It also includes a "not applicable" option in case the teacher is unable to answer a question.

The questionnaire classifies the competence level of teachers according to the European Framework for Digital Competence in Teaching (DigCompEdu) (Cabero Almenara & Palacios Rodríguez, 2020; INTEF, 2017; Tourón et al., 2018) with the following categories: Novice (A1), Explorer (A2), Integrator (B1), Expert (B2), Leader (C1) and Pioneer (C2). The reliability of the instrument was measured with a Cronbach's Alpha of 0.98 (Tourón et al., 2018)which guarantees its internal consistency.

Results

The following are the demographic results of the participants whose total number of participants was 34 teachers where 68% are female and 32% are male. As

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for the age of the respondents, the results indicate that 18% are in the 21 to 30 years old range, while 41% are between 31 and 40 years old. In addition, 21% of the participants are between 41 and 50 years old, 18% are between 51 and 60 years old, and 3% did not provide this information.

Regarding teaching experience, 41% of respondents have 1 to 5 years of experience, while 21% have 6 to 10 years and another 21% have between 11 and 15 years. Six percent of the participants have worked between 16 and 20 years, 9 percent have more than 20 years of teaching experience and 3 percent did not answer this question. Finally, with regard to academic qualifications, 68% of the respondents have a bachelor's degree, 24% have a master's degree and 9% have obtained a doctorate.

The results of the questionnaire applied show competency levels of C1 in knowledge and B2 in usefulness as shown in Table 1.

TABLE 1
Table and text model

Areas of Digital Competencies	Meet Competency Level	*%	Use Competency Level	*%
Information and Information Literacy	C1	74	B2	67
Communication and Collaboration	C1	79	B2	70
Digital Content Creation	C1	72	B2	61
Security	C1	75	B2	65
Troubleshooting	C1	76	B2	67

Note. Results of the questionnaire applied (Cabero-Almenara & Palacios-Rodríguez, 2020; INTEF, 2017; Tourón et al., 2018) A1=Novice; A2=Explorer; B1=Integrator; B2=Expert; C1=Leader; C2=Pioneer.
**Percentages (%) indicate group average by skill level.

Information and Information Literacy

The Information and Information Literacy area covers the critical evaluation of information, data and digital content, as well as the management and storage of these to facilitate their retrieval and organization. According to Table 1, in this area, 74% of the teachers demonstrate a knowledge level of Leader (C1), while 67% use these competencies reaching the level of Expert (B2).

Communication and Collaboration

The Communication and Collaboration area includes sharing information and content, acting as an intermediary and disseminating news and resources with proper citation practices, as well as promoting online citizen participation and technological empowerment. Table 1 shows that 79% of teachers have a knowledge level of Leader (C1), and 70% reach the level of Expert (B2) in the use of these competencies.

Digital Content Creation

In the area of digital content creation, teachers are able to integrate and rework existing resources to generate original and relevant content, understanding applicable

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copyrights and licenses. In terms of programming, they demonstrate knowledge of the basic principles for modifying programs and applications. In this area, 72% of teachers have a knowledge level of Leader (C1) and 61% reach the level of Expert (B2) in the use of these competencies, according to Table 1.

Security

In the area of security, teachers are aware of the importance of protecting personal data and digital identity, respecting privacy and protecting themselves against threats such as fraud and cyberbullying. In addition, they recognize the need to avoid physical and psychological health risks related to the use of technology and take into account the environmental impact of technology use. According to Table 1 in this area, 75% have a knowledge level of Leader (C1), while 65% reach an Expert level (B2).

Troubleshooting

In the area of problem solving, teachers. They are able to identify technological needs and answers, innovate and use digital tools in a creative way, participating in collaborative productions and generating knowledge to solve conceptual problems. In this area, 76% have a knowledge level of Leader (C1) and 67% reach the Expert level (B2), as shown in Table 1.

FIGURE 1

Levels and classification obtained by area
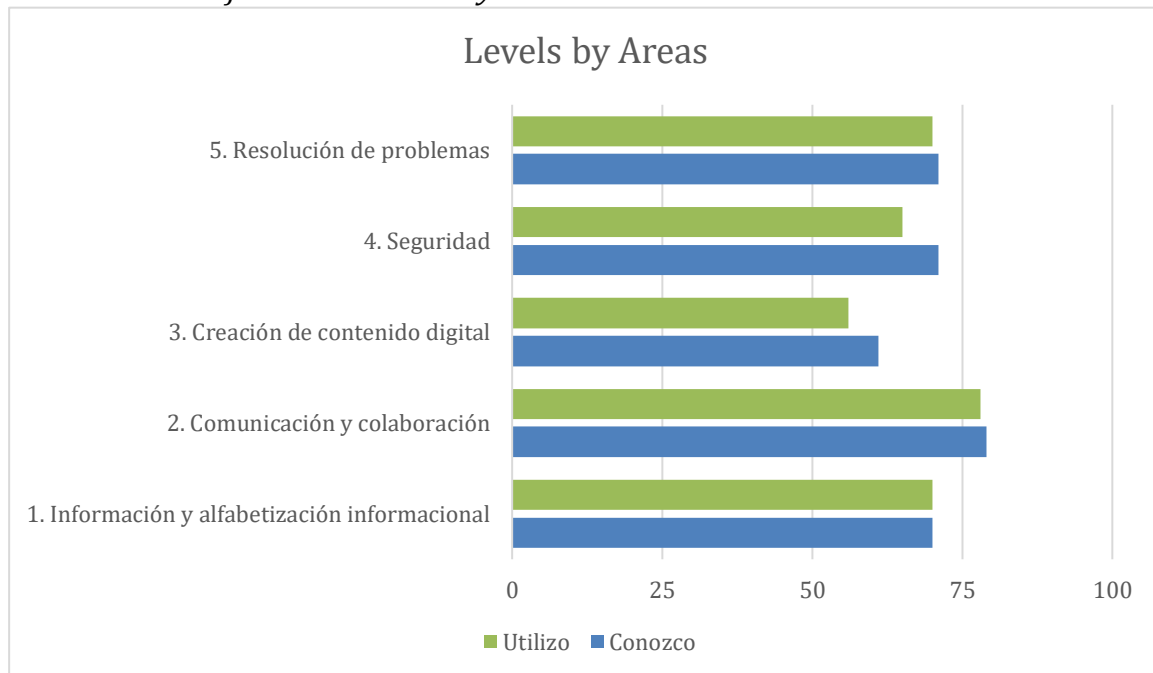
Note. Numerical rank at each level of mastery to evaluate the progress of the group. (Basic: 0 - 25 points, Intermediate: 26 - 50 points, Advanced: 51 - 75 points, Innovative: 76 - 100 points) Mastery levels: Basic: Elementary use of technology for simple classroom tasks. Intermediate: Integration of digital resources to support learning. Advanced: Robust and adapted use of technologies, fostering creativity and interaction. Innovative: Pedagogical transformation through the innovative use of technology (UNESCO, 2018).

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Discussion and Conclusions

Digital teaching competence is essential to train teachers capable of promoting learning focused on talent development, moving away from the traditional approach of knowledge transmission. Today's educational demands require methods adapted to the learning styles of students, who must be prepared for a globalized and digitalized society. To do so, learning must effectively integrate pedagogy, content and technology. The results presented in this report reflect the digital competence level of the surveyed teachers and how they can improve in their educational practice and professional training, as supported by the theories cited in this article.

Regarding the results of the statistical information, the participants reflect a female majority in the sample. Teachers predominate in the middle age group, with a distribution that suggests a significant representation of professionals in the middle stage of their career. In terms of experience, the findings indicate that most of the respondents are relatively young teachers.

With regard to academic degrees, the data reflect a diverse academic profile among teachers, with a notable proportion of undergraduates and a lower percentage of postgraduates. This variation in academic background could influence their educational practices and digital competence.

Linked to the area of Information and Information Literacy, it includes the ability to navigate, search and filter information, data and digital content efficiently, expressing information needs in an organized manner, finding relevant resources for teaching tasks and managing diverse sources. The results of which, when contrasted with the study by Orosco-Fabian et al. show that these studies coincide in that teachers have a satisfactory command of digital competencies related to browsing, searching and filtering information, as well as in the use of advanced tools to find appropriate resources. Both emphasize the ability of teachers to design personalized strategies to search for and constantly update relevant information.

Also, while these achievements are positive, teachers are still in the process of developing key competencies in areas such as information literacy, communication and collaboration, and digital security. This contrasts with the first statement that suggests a greater mastery in all the competencies mentioned, highlighting a gap in certain important digital areas that still require attention in their training. As observed in Orosco-Fabian's research findings (Orosco-Fabian et al., 2021).

Findings in the area of communication and collaboration encompass interaction through digital devices and applications, proper management of digital communication and tailoring strategies to specific audiences; it also involves the use of technologies for collaborative work, adherence to online behavioral norms (netiquette), and digital identity management to protect reputation. Teachers have a Leader competency level in these dimensions.

Regarding the use of sharing information and content; motivating their colleagues and students to evaluate and disseminate educational information through digital media; online citizen participation, as active users who express opinions and participate in debates in virtual educational and social spaces; as well as the ability to develop digital citizenship projects and collaboration through digital channels, they stand out as Experts, promoting the active participation of the educational community through collaborative tools in their teaching practice.

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In the area of netiquette, teachers have a solid knowledge of the rules of conduct in digital contexts while their use is Expert, reflecting that they respect these rules and cultural diversity in digital communication. Finally, in digital identity management, they reach an Expert level, with competencies to create and manage their digital identity and data. Also, in terms of use, their level is Expert, showing awareness of the influence of personal image in social networks and striving to manage it adequately but with limitations.

In spite of what was stated above about the Expert level in terms of utilization, which involves collaborating in the creation of digital educational products and organizing collaborative activities with students, this level should be aligned with the Leader level, as reflected in previous paragraphs. Similar to these findings are the researches (Escobedo & Jiménez, 2021; J. A. V. Pérez & Ortíz, 2020, 2020; V. A. Pérez & Velasquez, 2024; Rodríguez-Jiménez et al., 2022)where many teachers do not have the skills required to use ICT tools effectively in their pedagogical practice

In the area of digital content creation, teachers demonstrate skills to develop and enhance content in various formats, including multimedia creations, expressing themselves creatively through digital media.

They are classified as Leaders, since they are able to create didactic materials in different formats and publish them in different digital spaces. In terms of use, they reach the level of Experts, producing complex digital content and encouraging this type of production among their students.

In addition, in the breakdown of the specific dimensions of that area and in the device protection area. A diverse classification was observed in the findings. First, teachers demonstrate knowledge competencies to protect their devices and digital content, understanding the risks on the network and applying appropriate security measures. They also claim to have the skills to identify and solve technical problems, from the most basic to the most complex.

Second, in terms of personal data protection and digital identity, their rating is Leaders, because they frequently adjust privacy settings to improve their online protection. In health and wellness protection, they are also classified as Leaders, as they are aware of the correct practices in the use of technology to avoid health problems and protect themselves from cyberbullying. Finally, in environmental protection, their classification is Leaders, as they implement efficient strategies for the use of devices and make decisions that respect the environment, both in the purchase and disposal of equipment.

Third, although in the area of device and digital content protection, personal data protection, health, welfare and environment, teachers are classified as Leaders and Experts in terms of knowledge, the actual use of these tools shows a different reality. In practice, many of them are classified as Novices, which indicates that, although they possess the necessary knowledge, they do not apply it consistently in their daily work. This reflects a gap between the level of theoretical competence and its practical implementation, suggesting the need for further training and support to ensure a more effective use of these competencies in digital protection and management, as stated by Tourón et al (Tourón, 2018).

Similarly, with regard to copyright and licensing, they have a good knowledge of the subject and are classified as Experts, promoting training in the respect for copyright. However, in practice, many still do not apply these licenses, which places them at the Novice level in their use. Finally, in the area of programming, their classification is Explorers, as more than half make basic modifications to educational applications to

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adapt them to learning needs related to computational thinking. This classification can be confirmed by the theoretical postulates cited in this article (Cabero-Almenara & Palacios-Rodríguez, 2020; INTEF, 2017; Tourón, 2018; Tourón et al., 2018)

In the area of technical problem solving, teachers recognize the importance of identifying gaps in their digital competence, keeping up to date and supporting others in their digital development. They are classified as Experts, since they solve simple technical problems with the help of manuals or guides. Regarding the identification of technological needs and responses, they are considered Leaders, since they keep themselves updated on technological advances and select adequate solutions to solve problems in their teaching work. In innovation and creative use of technology, they are also classified as Leaders, demonstrating the ability to innovatively apply digital technologies in their teaching. Finally, in identifying gaps in digital competencies, they are classified as Knowledge Leaders, helping colleagues to develop their digital competencies, although their use is less frequent, being classified as Experts.

In contrast to other research, where it is noted that about 98% of teachers are at a basic level of digital competence and only use ICT in an elementary way (A. Martínez, 2021), the current findings show a higher level of progress. Although teachers report significant knowledge in areas such as device protection and creative use of technology, there is a notable discrepancy between what they know and what they actually apply, especially in the creation of digital content.

This contrast underscores the need for a strategic upgrade in the technological training of teachers, as suggested in previous studies, to ensure that they progress in daily practice to more advanced levels such as Leader or Pioneer (C2) (Tourón et al., 2018).

The digital competence of teachers is fundamental in today's education, as its continuous development not only benefits educators, but also improves the quality of the teaching and learning process in the digital era. This article highlights the need to invest in this competence to ensure a quality and relevant education in the current context, as pointed out in the theoretical references (Cabero-Almenara & Palacios-Rodríguez, 2020; Tourón, 2018; UNESCO, 2022)

Despite the benefits, teachers face challenges such as the digital divide and resistance to change. According to other research, secondary education teachers tend to have an intermediate level of digital competence, with deficiencies in areas such as digital content creation, problem solving and digital security (García et al., 2022).

Future research should focus on strategies to address the challenges faced by teachers and on the continued evolution of digital competencies in response to technological advances. This coincides with other studies that highlight the need to offer more training for teachers, supported by reliable and valid competency assessment tools (Palacios-Rodríguez & Martín-Párraga, 2021).

Digital technologies eliminate geographical barriers, facilitating continuous and distance learning, and favoring work-life balance. They allow self-paced learning, adapted to diverse intelligences, and ensure access to a wide variety of high quality information and learning materials. In addition, they introduce new ways of teaching that simplify teaching and improve student satisfaction. They also accelerate evaluative processes with immediate feedback and create virtual environments that strengthen the links between teachers and students (González, 2023).

The integration of ICT tools in the classroom offers significant benefits, but also presents challenges that must be adequately addressed. It is critical to ensure that all schools have access to technology, train teachers, and establish strong security and privacy policies. Investment in ICT in education is essential for the future of the teaching

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and learning process. This study has examined the digital competencies of teachers, highlighting both their advantages and obstacles. ICTs are powerful for improving education, but their successful implementation requires a comprehensive approach that addresses the needs of digitally competent students and teachers (Christine Redecker, 2020; UNESCO, 2018).

To identify digital competencies in teachers, a clear and well-defined approach is needed, as well as the development of skills that respond to the educational objectives and needs of students. Making informed decisions about the technology that best suits these needs is crucial, aligning with established educational criteria. Collaboration with peers and expert guidance in the technology inclusion process can facilitate adaptation(Tourón et al., 2018).

Digitally competent teachers encourage group work and use ICT effectively, supporting collaboration and adaptation to technological integration. Their confidence to innovate and their ability to see change as an opportunity to grow are vital. These teachers show flexibility and are willing to learn from their own mistakes and from others. In addition, they invite others to delve deeper into the use of technological resources and propose innovative projects that address various needs, such as parent and student training.

In the same way, they implement digital projects based on active methodologies such as gamification, Flipped Classroom and project-based learning. In summary, digitally competent teachers are restless, investigative, active and proactive in technology education (Tourón, 2018; Tourón et al., 2018).

In conclusion, the results show that the teachers surveyed reach a level of "Leader" in knowledge, but only "Expert" in usefulness. This indicates that, although secondary school teachers possess strong digital competencies in terms of knowledge, their practical application is below that level, according to the classification of Digital Teaching Competence proposed by Tourón et al (Tourón et al., 2018). This evidences the need for additional training in the use of advanced tools and their pedagogical integration. It is recommended to implement specific training programs that address these gaps to improve the quality of teaching and learning in digital environments.

After applying the Digital Competence in Teaching (CDD) questionnaire by Tourón and collaborators, recommendations have been formulated to improve the development of teachers' digital competencies, identifying their level and classification according to the European Framework, since the ideal levels of mastery to support and transform teaching and learning through the use of technologies are in the advanced and innovative ranges (UNESCO, 2018). It is important to note that these suggestions are based on the profile obtained from the group under investigation, and their validity depends on the individual responses of the teachers and their variability.

One of the main recommendations is to evaluate the quality of educational resources available on the Internet, ensuring that they are accurate and aligned with the curriculum. In addition, it is suggested to investigate the provenance, reliability, authorship and licensing of the resources before using them in class. It is also essential to select appropriate communication tools, taking into account the target audience, whether students, teachers, families or school management. As stated in the theoretical postulates (Cabero-Almenara & Palacios-Rodríguez, 2020; Tourón, 2018)

Teachers are also encouraged to plan activities that allow students to experiment with different collaborative networking tools. Using social networks to communicate with students is also a viable option, as long as rules of use are established and netiquette is

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respected. It is also advisable to follow teachers or experts in online education, which will allow you to learn and share best practices (Tourón, 2018; UNESCO, 2018, 2022).

In addition, it is proposed to expand the use of administrative procedures and digital signatures in interactions with the public administration. Staying informed about cyberbullying and appropriate uses of the Internet is crucial to detecting potential problems. Encouraging discussions about netiquette and promoting related activities will help build digital awareness in the classroom.

Finally, the importance of learning how to identify and act in cases of cyberbullying among students, ensuring the privacy of information on school devices is emphasized.

Updating on new tools that facilitate the creation of interactive content and the collection of information on student progress is essential (Tourón, 2018). Complementing training on copyright, healthy habits and the environmental impact of consumables use is also a key aspect of responsible and effective educational practice.

Finally, the results of this study confirm that, although secondary education teachers possess general digital competencies at both Leader and Expert levels, they lack the advanced skills necessary to optimize the use of technology in teaching. In addition, there should be a correspondence between knowledge and use of these competencies. However, the findings show that there is no such correspondence, and the two aspects do not align as would be expected. In theory, knowledge and use should be equivalent.

These findings are consistent with previous studies that have pointed to the need for ongoing training for teachers in areas such as digital content creation and online assessment. Limitations of this study include the small sample size and the lack of diversity in the educational contexts evaluated, suggesting that future research should expand the sample and consider other institutions. Despite these limitations, the study highlights the importance of designing training programs that are better adjusted to the current needs of teachers.

Conflict of Interest

It is important to declare that there is no conflict of interest related to this research. All authors have conducted the study in an unbiased and transparent manner, with no external influences that could affect the results or conclusions presented. We are committed to maintaining academic integrity and research ethics, ensuring that findings are based solely on the evidence gathered and objective evaluation of the data.

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Formative Assessment and Artificial Intelligence: Strategies for Human and Effective Learning

Evaluación Formativa e Inteligencia Artificial: Estrategias para un Aprendizaje Humano y Eficaz

Héctor Fernández Cuevas
Benemérita Universidad Autónoma de Puebla, México(hector.fernandezcu@correo.buap.mx)(https://orcid.org/0009-0004-5090-9930)

	ABSTRACT
Keywords: Formative assessment, artificial intelligence, higher education, personalized feedback, meaningful learning	This study analyzes the impact of personalized feedback on formative assessment in higher education, considering the role of artificial intelligence in this process. A mixed-methods design with both qualitative and quantitative approaches was used, collecting data through surveys and response analysis on digital learning platforms. A total of 150 student responses from various institutions were analyzed to assess the effectiveness and perception of feedback. Results indicate that personalized feedback enhances meaningful learning and student motivation, although challenges remain for large-scale implementation. Pedagogical implications are discussed, and strategies are proposed to optimize its use in digital environments.
	RESUMEN
Palabras clave: Evaluación formativa, inteligencia artificial, educación superior, retroalimentación personalizada, aprendizaje significativo	Este estudio analiza el impacto de la retroalimentación personalizada en la evaluación formativa dentro de la educación superior, considerando el papel de la inteligencia artificial en este proceso. Se empleó un diseño mixto con un enfoque cualitativo y cuantitativo, recolectando datos mediante encuestas y análisis de respuestas en plataformas digitales de aprendizaje. Se analizaron 150 respuestas de estudiantes de distintas instituciones, evaluando la efectividad y percepción de la retroalimentación. Los resultados indican que la retroalimentación personalizada mejora el aprendizaje significativo y la motivación de los estudiantes, aunque existen desafíos en su implementación a gran escala. Se discuten implicaciones pedagógicas y se proponen estrategias para optimizar su uso en entornos digitales.

Introduction

Formative assessment seeks to foster responsible and reflective learning in students through the active guidance of teachers, who can systematically organize the learning process. Therefore, the need to reconsider formative assessment arises because it currently represents one of the most complex challenges in classroom teaching, given that it tends to be mostly quantitative and focused on academic performance. (Garcia et al., 2021)

In the current context of higher education, the integration of artificial intelligence (AI) in assessment offers opportunities to improve the accuracy, objectivity and efficiency of this process, however, it is crucial to maintain a human focus in formative assessment, ensuring that the emotional, social and ethical aspects of learning are not compromised in advanced technological environments (Van der Kleij et al., 2015).

In recent years, artificial intelligence (AI) has revolutionized the field of education, transforming the way in which teaching and learning take place. This technological advance has allowed for greater interaction between teachers and students, as well as a more efficient flow of information. According to Obaya (2003), information and communication technologies (ICT) facilitate social relations, cooperative learning and the development of new skills, promoting creativity, communication and reasoning.

The use of artificial intelligence represents an innovative tool that favors individualized learning, adapting to the learning styles and rhythms of each student. This type of software can be seen as a study partner with which various interactions can be established. Abarzúa and Cerda (2011), cited in Rojas, Gómez and García (2013), point out that the use of various digital tools contributes to the appreciation of diversity in the classroom by considering the individual differences of students, which makes them feel that their learning process is personalized and not comparative with that of their peers.

To investigate effective strategies to improve formative assessment in higher education in an environment where AI plays a relevant role, we seek to understand how these strategies can maintain a more humane monitoring of learning, considering the challenges and opportunities that arise from the integration of AI in educational assessment, in addition, we intend to provide practical recommendations for educators and designers of assessment systems to take full advantage of the capabilities of AI without losing sight of the importance of human interaction in the learning process.

The effective integration of artificial intelligence (AI) in formative assessment in higher education can significantly improve the accuracy, objectivity and efficiency of the assessment process, while maintaining a human approach that safeguards the emotional, social and ethical aspects of learning, by identifying and applying appropriate strategies for this integration and achieving a more effective and humane monitoring of learning, thus offering benefits for both students and educators.

Internationally, studies such as Tumoi (2018) have explored the impact of AI on formative assessment and proposed approaches to optimize its use in the educational process. They have demonstrated how AI can provide more accurate and detailed data analysis, enabling more personalized and effective feedback for students similarly they have analyzed how AI can personalize assessment to better serve individual student needs. This type of work highlights the importance of careful integration of AI in formative assessment to ensure meaningful student learning outcomes and highlights the need to address ethical and social issues in this integration.

In the current era, artificial intelligence (AI) has played a significant role in transforming education, redefining both teaching methods and learning processes. This

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technological evolution has led to greater interaction between teachers and students, as well as an optimization in the transfer of knowledge. According to Obaya (2003), information and communication technologies (ICT) not only improve social relations in the educational environment, but also facilitate collaborative learning, stimulate the development of new skills and promote creativity, communication and reasoning.

The use of artificial intelligence has become an innovative tool that favors personalized learning, adapting to the different learning styles and rhythms of each student. This type of tool contributes to the recognition and appreciation of diversity in the classroom, while giving students the feeling that their learning process is unique and personalized, without comparisons with others. Abarzúa and Cerda (2011),

It is essential to highlight the importance of digital literacy and inclusive education in the context of artificial intelligence applied to education. These aspects allow students to work autonomously and strengthen their individualized learning.

In the field of higher education, formative assessment has been the subject of numerous studies that seek to understand its impact on the learning process of students. For example, Cabero-Almenara and Palacios-Rodriguez, (2021) conducted a comprehensive systematic review on the integration of assessment tools in digital education at the higher level, their work highlights the importance of these tools to provide personalized feedback and improve the learning experience of students.

However, it is important to take into account ethical considerations in the use of AI in educational assessment, as this is a subject of debate and study. A UNESCO research (2021) conducted a policy analysis on AI-driven education and assessment, highlighting the need to address aspects such as privacy, equity and transparency in these practices, as it is essential to understand students' perceptions of AI-based assessment tools.

These previous works provide a theoretical and empirical basis for the development of this study on the importance of improving formative assessment in higher education in the era of artificial intelligence. First, previous research has identified the existing limitations and challenges of traditional formative assessment methods, highlighting the need for more dynamic and adaptive approaches that align with the changing demands of today's educational environment.

In addition, these studies have demonstrated the potential of artificial intelligence to significantly improve the formative assessment process. By analyzing large volumes of data and using advanced algorithms, artificial intelligence can provide personalized *insights* and recommendations that enable educators and students to identify areas for improvement more accurately and efficiently.

The existing literature underlines the importance of taking advantage of the capabilities of artificial intelligence to improve formative assessment in higher education, without losing sight of the limitations, regulations and the human sense that education should have.

Method

The present study focuses on investigating innovative strategies to improve formative assessment in higher education, specifically in relation to the integration of artificial intelligence (AI) in educational assessment processes in higher education. The scope of this research encompasses both the exploration of the existing literature and the detailed analysis of a case study at the higher education level on formative assessment strategies using AI. The objective is to understand in depth how these strategies can contribute to a more humane monitoring of learning, considering the challenges and opportunities that

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arise from this technological integration in education and what is the perception of students regarding their application in the teaching-learning process.

The methodological design of this study combines a qualitative and quantitative approach to comprehensively address the research objective. The literature review was carried out systematically, using recognized academic databases and consulting high-impact sources in the field of education and technology, and a detailed case analysis of the perception of higher education students on the use of artificial intelligence in their learning. This combination of approaches provides a holistic and in-depth view of the subject under study.

Sample and Method of Sampling.

The sample for the case analysis was selected intentionally and representatively, considering criteria such as the diversity of technological approaches used, the size and type of population in contact with the use of AI.

A questionnaire of 17 questions was carried out, including open and closed questions, as well as the follow-up of a schedule of activities, the questionnaire was applied to 85 students from different higher education careers in the state of Puebla, Mexico, whose age ranged between 18 and 23 years, having 49 women and 36 men in the study. For the application of the questionnaire, a previous review of the bibliography was made, as well as its validation, which was previously piloted with a group of students. For its implementation, a document on the ethical considerations of the study to preserve the confidentiality of the data collected from the participants, as well as a link to the questions, was sent by e-mail invitation.

Applied Statistical Analysis

Data analysis was carried out using both qualitative and quantitative techniques. For the qualitative analyses of the case studies, a content analysis approach was applied to identify significant patterns, themes, and relationships related to formative assessment and the use of AI, and descriptive and comparative statistical techniques were employed to examine the effectiveness and impact of formative assessment strategies with AI on students' performance and learning experience.

The statistical analysis was mostly done through *Google forms and Excel*, being these tools instruments used for the analysis of the responses collected which were interpreted through graphs that show a detailed overview of the study.

Limitations of the study.

It is important to recognize that this study may face some limitations, such as the limited availability of detailed data on the implementation of formative assessment with IA in certain educational contexts, and the qualitative approach may not fully capture the complexity and diversity of participants' experiences and perceptions.

Likewise, the growing development and evolution of artificial intelligence, which is at an accelerated pace, implies that the results obtained may be very different in a few more months due to the change in new technologies, as well as in their use and insertion in the daily life of students.

Another limitation is the context in which the study was applied, since the results obtained may vary considerably in their application from one region to another, and even between public and private sector universities. However, formative assessment is something present in any institution, but its interaction in virtual environments or where there is the use of artificial intelligence may present variations.

Results

The study yielded several considerations which are worth analyzing and highlighting, since they mention important aspects of the students' perception of formative assessment in higher education. To begin with, more than 80% of the respondents show some degree of familiarity with the concept of formative evaluation, so that only a few are unfamiliar with the term.

Graph 1.

3. ¿Crees que la integración de la inteligencia artificial en la evaluación formativa puede mejorar la calidad de la retroalimentación que recibes por parte de tu docente?

85 respuestas

- Sí
- No
- No estoy seguro/a
- Tal vez
- De pende en qué aspecto sea utilizado
- No concibo el hecho de que la IA se pueda utilizar como metodo de evaluación, no he tenido una prueba al respecto

29,4%
21,2%
45,9%

Source: author's elaboration.

With respect to the previous question we can visualize that more than 90% of the students consider that the use of artificial intelligence can translate into an improvement in the feedback they receive from their teachers, which leads us to highlight the importance that artificial intelligence is taking in the classroom, essentially in the way in which they receive feedback on their evaluations.

Graph 2

4. ¿Qué aspectos consideras más importantes al recibir retroalimentación sobre tu aprendizaje? (Selecciona todas las opciones que apliquen)

85 respuestas

Aspecto	Respuestas
Claridad	75 (88,2 %)
Pertinencia	39 (45,9 %)
Personalización	60 (70,6 %)
Rapidez	28 (32,9 %)
Creatividad	1 (1,2 %)
Ser interactivo	1 (1,2 %)
Que sea personalizada enfoca…	1 (1,2 %)

Source: author's own elaboration.

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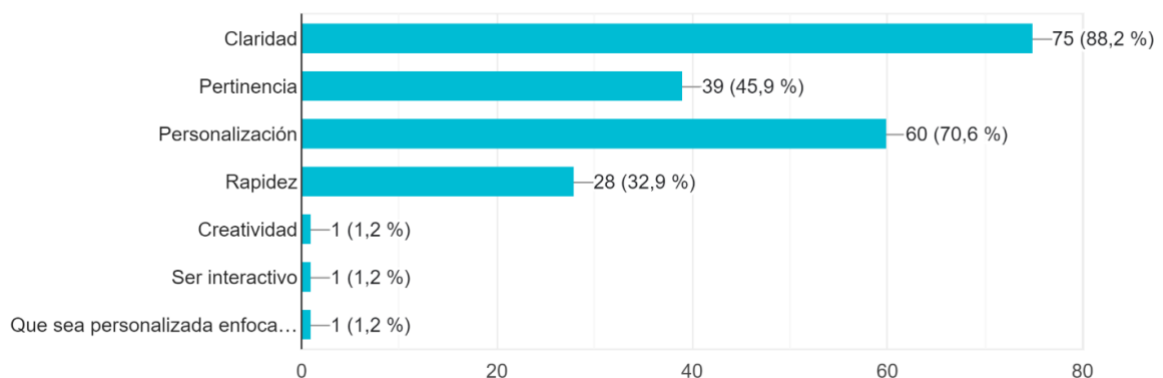
Regarding the aspects they consider most relevant when receiving feedback, there is an inclination towards personalization and clarity, over relevance, speed and creativity, aspects that are relevant, but according to the results are not predominant in the respondents. This leads us to the analysis of the following graph, where the students are divided into those who would opt for an AI to carry out part of their learning process and another part chooses the evaluation carried out by a human being, in this case their teacher of the subject in question.

Graph 3.

5. ¿Te gustaría tener acceso a herramientas de evaluación basadas en IA en tu proceso de aprendizaje?
85 respuestas

Source: Author's elaboration.

The results of question number 5 reveal a range of perspectives on whether artificial intelligence (AI) could outperform the teacher in identifying areas for improvement in learning. Some see AI as having greater potential because of its ability to offer a diversity of tools and approaches that a human teacher might not fully embrace, respondents argue that AI, with its accuracy and ability to identify specific errors, could provide more detailed feedback tailored to the individual needs of each student.

According to Aung et al. (2021) The impact of artificial intelligence on the evaluation and classification process is significant. AI not only influences teaching and learning, but also student assessment and grading. For example, AI examines assignments and research projects using tools such as Turnitin, which compares student work against a large database in a short time. This makes it easy to identify similarities and determine whether plagiarism has occurred. In addition, rubrics and online grading forms are used that specify criteria and scales for evaluating tasks, and final grades are automatically calculated without complications (Mahana et al., 2012). Artificial intelligence also offers interactive ways to provide constructive feedback to students, allowing easy and flexible access anytime, anywhere, ensuring greater privacy and autonomy. Also, instructors can provide written or recorded feedback to facilitate learning from mistakes.

On the other hand, there are those who defend the effectiveness of the human teacher, highlighting their ability to explain in a clearer and more personalized way (in a human way), taking into account aspects such as the personality and learning habits of each student, in addition, they value the emotional connection and experience that a teacher can offer, as well as the necessary balance between the use of technology and the integral development of learning.

According to Gómez Vahos, Muriel Muñoz and Londoño-Vásquez (2019), the role of the teacher is fundamental for the achievement of meaningful learning supported by ICTs highlighting the importance of integrating technological tools in educational training. These technologies are seen as a way to expand the capacity to create, share and master knowledge, being a crucial factor in today's global economy and in the rapid evolution of society (Piscitelli, 2002)

Among the neutral or mixed opinions, there is the idea that AI could be useful as a complement to identify areas for improvement, but that the presence and guidance of the teacher are still essential in the educational process. The possibility of using AI as an additional tool to adapt to individual learning needs and provide faster and more accurate feedback where the predominant factor is human is mentioned. (Ayuso and Gutierrez, 2021)

Continuing with the analysis of the results of question 10, the following assumptions are obtained 10. Do you think AI could improve equity in formative assessment by considering the individual needs of students? Why? The question generated a variety of interesting responses and perspectives. In these 85 responses, several key points are revealed that reflect both the potential and perceived limitations of AI in this context, which are described in the table below.

Table 1.

Key aspects of the use of AI to promote equity in formative assessment

Aspects	Description
Customization and Ease of Use	Many responded in the affirmative, highlighting the ability of AI to personalize the assessment without undue effort. This suggests that AI could be tailored to the specific needs of individual students more efficiently than traditional methods.
Support and Complement	Others see AI as a support tool or a complement to the teacher's work, indicating a vision of collaboration between technology and faculty for the benefit of students.
Adaptation to Individual Needs	The ability of AI to adapt to individual needs is repeatedly mentioned as a key factor in its potential to improve equity in assessment. Personalized feedback and elimination of bias are highlights in this regard.
Limitations and Ethical Concerns	However, ethical and practical concerns are also raised. Some express doubts about the ability of AI to fully understand the emotional and contextual needs of students, as well as to address all relevant assessment parameters.
Variety of Perspectives	Responses reflect a wide range of perspectives, from confidence in AI's ability to improve equity to caution about its limitations and the continuing role of the teacher in the educational process.
Fair and Accessible Evaluation	Many recognize the potential of AI to provide fairer and more accessible assessment, especially when it comes to personalizing feedback and adapting to unique learning styles.

Source: Author's elaboration with information from Hernández León, N. (2025). *Artificial intelligence applied to university educational assessment*. Universidad de Salamanca.

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The responses show that while AI has the potential to improve equity in formative assessment by considering the individual needs of students, it also raises important challenges and questions that need to be addressed ethically and practically. Collaboration between technology and faculty, with a focus on personalization and elimination of bias, could be key to maximizing the potential of AI. (Ponce López, J.L. and Castañeda de León, L.M. 2023).

Continuing with the analysis in question 12. Do you think AI could help teachers identify the specific needs of individual students more efficiently? How can I help you? The responses were analyzed by dividing them into 8 points to be considered.

I. Data Analysis and Personalized Recommendations: A considerable number of responses highlight the ability of AI to analyze student performance data and provide personalized recommendations to address their individual needs. This suggests that AI can be useful in identifying patterns and trends that teachers might miss.

II. Support in the Personalization of Teaching: It is mentioned that AI can be a support tool to personalize teaching and adapt it to the learning styles of each student. This could improve the efficiency of teaching by specifically targeting the areas that require attention, which is going to be determinant depending on the area of study they are in

III. Registration and Progress Tracking: Some responses highlight the ability of AI to keep a detailed record of each student's progress, which would make it easier for teachers to have access to clear and actionable information about their students' needs, which represents a great challenge because there is still a lot of ignorance about AI within the teaching profession.

IV. Information Organization: It is mentioned that AI could help organize information about students' needs into tables or profiles, which would facilitate the identification of areas for improvement and the planning of teaching strategies.

V. Evaluations and Feedback: AI could conduct periodic evaluations and provide detailed feedback to teachers on each student's performance and areas of difficulty, which would contribute to more individualized attention, however, the human factor would still be predominant in this type of feedback.

VI. Potential for Improvement and Warnings: Some responses express the idea that, while AI has potential to assist in identifying needs, it should not be considered the only tool and care should be taken to avoid generalities that do not apply to all students and that feedback and guidance from a human teacher is not lost amidst the use of

The responses show an overall positive perception of the role of AI in identifying student needs by teachers, the ability of AI to analyze data, provide personalized recommendations and support individualized teaching, these elements are considered as key aspects that could improve the efficiency and effectiveness of education, however, it is also emphasized the importance of not relying exclusively on AI and to consider its use as a complementary tool in the educational process.

Related to this, it is important to point out that the use of generative artificial intelligence in higher education is beginning to be studied from an ethical and academic integrity perspective. According to Gallent-Torres, Zapata-González and Ortego-

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Hernando (2023), a mostly positive reception towards the role of AI in the identification of students' needs by teachers has been observed, however, the importance of considering it as a complementary tool in the educational process is stressed, thus maintaining a balance between technological use and attention to academic integrity from the human perspective. This leads us to the analysis of the following graphs.

Figure 4.

15. ¿Consideras que los docentes deberían recibir capacitación adicional sobre cómo utilizar herramientas de evaluación formativa basadas en IA?
85 respuestas

- Sí
- No
- No estoy seguro/a

88,2% 11,8%
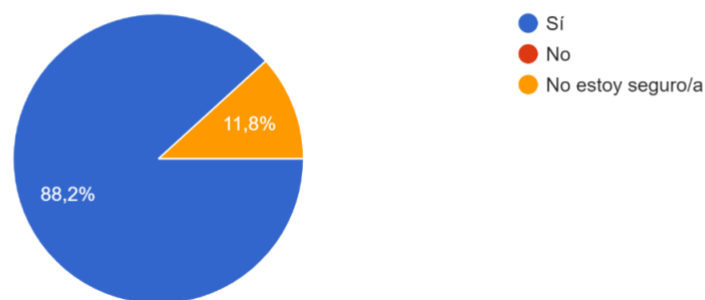
Source: Author's elaboration.

Graph 5.

16. ¿Crees que el aprendizaje es un proceso que debería ser facilitado principalmente por los docentes, seres humanos con habilidades de enseña...ayormente a sistemas de Inteligencia Artificial?
85 respuestas

- Sí, considero que el aprendizaje debe ser principalmente facilitado por los d…
- Sí, pero creo que la IA puede ser una herramienta complementaria útil en el…
- No tengo una opinión clara al respecto.
- No, creo que la IA puede desempeñar un papel significativo en el proceso de…
- No, considero que el aprendizaje pue…
- Si, siempre será muy diferente que un…
- Considero importante que la enseñan…

61,2% 35,3%

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Source: Author's own elaboration.

The information gathered through the answers to the two questions reveals an interesting picture about the perception of the respondents regarding the use of Artificial Intelligence (AI) in education and the role of teachers in this context.

First, with regard to the training of teachers in the use of AI-based formative assessment tools, there is a marked division. On the one hand, a small percentage (11.8%) advocate the need for teachers to receive additional training in this area, suggesting an interest in improving educational technology skills; on the other hand, the vast majority (88.2%) believe that teachers already have the necessary skills to use these tools without requiring additional training, reflecting confidence in their current abilities.1

Regarding the role of AI in the educational process, the majority of respondents (61.2%) emphasize the importance of learning being facilitated primarily by teachers, highlighting the human skills of teaching and emotional understanding as fundamental. This position suggests a deep appreciation of the role of the teacher as a guide and facilitator of learning.

On the other hand, a significant percentage (35.3%) consider that AI can play a useful complementary role in the learning process. This indicates a recognition of the potential of AI to enhance and enrich the educational experience, though without replacing the central, human role of the teacher. The responses reflect a majority position that values the essential role of teachers in education, emphasizing their human skills and their ability to guide and emotionally understand students, aspects that after the pandemic caused by COVID 19 are taken into account even more in education.

Finally, the study concludes with question 17. What recommendations or suggestions would you have to improve the implementation of formative assessment in higher education in times of artificial intelligence? Based on the students' responses we can make the following analysis: By carefully studying the answers provided in this question on how to improve the implementation of formative assessment in higher education in the era of artificial intelligence, valuable insights emerge that illuminate the way towards a more effective education, and adapted to technological advances, to better present the information collected the following table was prepared.

Table2.
Recommendations for improving formative evaluation in times of IA

Appearance	Recommendation
Consider artificial intelligence as a complementary tool.	Recognize the unique value of human interaction in learning and use artificial intelligence to enhance and complement traditional teaching, rather than replace it entirely.
Personalization in the evaluations.	Use artificial intelligence capabilities to provide assessments tailored to the individual needs of each learner, adjusting the pace of learning and providing specific feedback.
Careful and moderate use of artificial intelligence	Warn about the importance of not relying exclusively on artificial intelligence, maintaining a balance with human skills in education to take full advantage of both capabilities.

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1 The counter position of opinions opens an approach that could be analyzed in future studies regarding the teacher's perspective on their interaction with AI.

Appearance	Recommendation
Student participation	Encourage self-assessment, personalized goal setting and student participation in their own educational process to improve their academic engagement and success.
Integrating vision	Promote a vision that combines the advantages of technology with the valuing and strengthening of human skills in education, seeking a balance that benefits both students and educators.

Source: Author's elaboration with information from: Aung, T., Khaing, A. K., Lwin, Z. H., Abdullah, N. A., Soe, K. K., and Htwe, M. Z. M. (2021). The impact of artificial intelligence on learning and teaching in higher education: A systematic literature review. *International Journal of Advanced Computer Science and Applications, 12(3), 353-361.* https://doi.org/10.14569/IJACSA.2021.0120345

Recommendations for improving the implementation of formative assessment in higher education in times of artificial intelligence advocate an integrative vision that takes advantage of the benefits of technology while valuing and enhancing human skills in the educational process.

Discussion.

Initially, the limitations identified during the research are highlighted, although a significant amount of data was collected, it is important to note that the study sample may not fully represent the diversity of opinions and perspectives regarding the use of artificial intelligence in formative assessment.

On the other hand, the strengths of this study include the variety of responses and perspectives gathered, which provides a broad and diverse view of the higher education community's perception of the impact of artificial intelligence on formative assessment, and the implementation of artificial intelligence as a complementary tool in the formative assessment process is considered a promising opportunity to improve equity and personalization in educational feedback.

Regarding the opportunities identified, it is suggested the need to develop training strategies and training for teachers and students in the effective use of artificial intelligence in evaluation, this could contribute to optimize the use of technological tools and improve the quality of feedback provided to students, adapting more accurately to their individual learning needs.

It is important to mention that there is enormous ambivalence regarding AI. On the one hand, great hopes and expectations are raised, close to a technological "solutionism" according to which all our problems (economic, social, environmental) will be solved with the development and use of AI and other converging technologies. On the other hand, there is a huge social ignorance (among citizens, companies, institutions and organizations) about AI, its possibilities, potential benefits and risks (Ausín, 2021).

The important value chain provided by using, sharing and reusing data through AI algorithms to generate public policies focused on anticipatory education, services, economic activity and social denunciation actions, both at macro (institutions and administrations), meso (organizations and companies) and micro (associations and individuals) levels, is not socially perceived. Lack of knowledge translates into a distorted perception of this technology, where its performance, implications and limitations can only be evaluated in the medium and long term. (Ausín, 2021).

Discussion and Conclusions

The research and analysis of the responses provided by the participants yield important insights into the implementation of formative assessment in higher education in the age of artificial intelligence. One of the key points to emerge is the need to provide additional training to teachers in the effective use of AI-based tools. This aspect is based on the idea of providing them not only with technical knowledge, but also with practical guides, continuous advice and specialized courses that enable them to integrate AI efficiently into their pedagogical practices.

A relevant finding is the perception shared by many participants that AI should be seen as a complementary tool and not as a total replacement for human learning. It highlights the importance of maintaining a balance between the capabilities of AI to provide personalized assessments, adapt the pace of learning and provide specific feedback, and the unique human skills such as personal interaction, empathy and emotional understanding provided by teachers.

In this sense, teacher training acquires a fundamental role, as it allows them to take full advantage of AI capabilities while maintaining a holistic perspective of education, where socioemotional aspects of education can greatly complement the use and application of AI in education. This implies not only mastering technological tools, but also developing pedagogical strategies that effectively integrate AI into the educational process, thus ensuring an enriching, equitable and humanistic learning experience for all students.

Another relevant finding is the need to actively involve students in their own educational process through the use of AI, as it can play a crucial role in allowing them to self-assess, set personalized goals, participate in activities tailored to their learning styles, and receive timely and specific feedback. This collaboration between technology and student participation contributes to a more dynamic, inclusive and student-centered educational environment, which must be combined with the human guidance of the teacher.

To conclude, effective implementation of formative assessment in higher education in times of AI requires a comprehensive approach that combines teacher training, a balance between human and technological capabilities, and student participation. These reflections are based on the valuable input and recommendations provided by the participants, highlighting the importance of a collaborative and balanced vision in education. Likewise, include experiences and learning that are meaningful for students, which can include guidance and feedback from a socioemotional perspective that only the human side can provide, this does not work separately from technological advances, on the contrary, it complements and strengthens education.

Notes.

In the context of this analysis and reflection on the implementation of formative assessment in higher education in the era of artificial intelligence, no specific financial support is applied. In the process of developing this analysis on the implementation of formative assessment in higher education in the era of artificial intelligence, *ChatGPT* was used as a tool to improve the initial writing. Each paragraph was modified and reviewed

by the author to ensure consistency and accuracy of the content presented. In this sense, the use of *ChatGPT* enriched the writing and clarity of the text, although the content and conclusions are the sole responsibility of the author based on the responses collected and analyzed from the participants. If more information on the methodology or the questionnaire applied is required, please contact the author of the article for further details.

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