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Sophia 38: 2025.

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Sophia 38: 2025.

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Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 21-24.

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Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 21-24.

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Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 21-24.

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In the context of research and scientific publications, the CRediT Taxonomy (Contributor Roles Taxonomy) is a standardized system used to classify and acknowledge the specific contributions of authors and collaborators in the research process and the development of scientific articles. The aim of this system is to promote transparency, equity, and proper recognition of the roles performed by each collaborator in scientific production.

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The author and their collaborators must explain the contributions made during the research process and the results achieved, in accordance with the guidelines outlined in the CRediT Taxonomy.

The CRediT Taxonomy includes 14 roles that can be used to determine the specific actions performed by researchers in the process, structuring, and presentation of research results.

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 25-27.

Distribution of participation roles through which an author can receive recognition in the publication (CRediT Taxonomy)*

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3. Formal Analysis	Application of statistical, mathematical, computational, or other formal techniques to analyze or synthesize study data.	https://credit.niso.org/contributor-roles/formal-analysis/ ID: 95394cbd-4dc8-4735-b589-7e5f9e622b3f
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5. Investigation	Conducting a research and exploration process, specifically performing experiments or collecting data/evidence.	https://credit.niso.org/contributor-roles/investigation/ ID: 2451924d-425e-4778-9f4c-36c848ca70c2
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Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 25-27.

Criterion	Description	Identification
9. Software	Programming, software development; design of software programs; implementation of computer code and supporting algorithms; testing of existing code components.	https://credit.niso.org/contributor-roles/software/ ID: f89c5233-01b0-4778-93e9-cc7d107aa2c8
10. Supervision	Responsibility for supervision and leadership in planning and executing research activities, including external mentoring of the central team.	https://credit.niso.org/contributor-roles/supervision/ ID: 0c8ca7d4-06ad-4527-9cea-a8801fcb8746
11. Validation	Verification, either as part of the activity or separately, of the general replication/reproducibility of results/experiments and other research outputs.	https://credit.niso.org/contributor-roles/validation/ ID: 4b1bf348-faf2-4fc4-bd66-4cd3a84b9d44
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By consensus, the authors of the document declare that the proposed article has not been previously submitted or published in other media outlets.

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Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 25-27.

Taxonomía de roles de los colaboradores (CRediT)

En el contexto de la investigación y las publicaciones científicas, la Taxonomía Credit (CRediT, siglas de *Contributor Roles Taxonomy*) es un sistema estandarizado para clasificar y reconocer las contribuciones específicas de los autores y colaboradores en los procesos de investigación y en la elaboración de artículos científicos. Este sistema tiene como objetivo promover la transparencia, la equidad y el reconocimiento adecuado de los roles desempeñados por cada uno de los colaboradores en la producción científica.

Contribuciones

El autor y sus colaboradores deben explicar las contribuciones que efectuaron en el proceso de la investigación y en los resultados alcanzados considerando la normativa expuesta en la Taxonomía CRediT.

La Taxonomía CRediT, incluye 14 roles, que se puede utilizar para determinar las acciones específicas que desempeñan los investigadores dentro del proceso, estructuración y presentación de los resultados de la investigación.

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 29-31.

Distribución de los roles de participación mediante la que un autor puede tener el reconocimiento en la publicación (Taxonomía CRediT)*

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2. Curación de datos	Actividades de gestión para anotar (producir metadatos), depurar datos y mantener datos de investigación (incluido el código de software, cuando sea necesario para interpretar los datos) para su uso inicial y posterior reutilización.	https://credit.niso.org/contributor-roles/data-curation/ ID: f93e0f44-f2a4-4ea1-824a-4e0853b05c9d
3. Análisis formal	Aplicación de técnicas estadísticas, matemáticas, computacionales u otras técnicas formales para analizar o sintetizar datos de estudios.	https://credit.niso.org/contributor-roles/formal-analysis/ ID: 95394cbd-4dc8-4735-b589-7e5f9e622b3f
4. Adquisición de financiación	Adquisición del apoyo financiero para el proyecto que conduce a esta publicación.	https://credit.niso.org/contributor-roles/funding-acquisition/ ID: 34ff6d68-132f-4438-a1f4-fba61ccf364a
5. Investigación	Llevar a cabo un proceso de investigación y exploración, específicamente realizando los experimentos o la recopilación de datos/evidencias.	https://credit.niso.org/contributor-roles/investigation/ ID: 2451924d-425e-4778-9f4c-36c848ca70c2
6. Metodología	Desarrollo o diseño de metodología; creación de modelos.	https://credit.niso.org/contributor-roles/methodology/ ID: f21e2be9-4e38-4ab7-8691-d6f72d5d5843
7. Administración de proyecto	Responsabilidad de supervisión, gestión, coordinación y liderazgo de la planificación y ejecución de las actividades de investigación, incluyendo la tutoría externa al equipo central en el caso de existir.	https://credit.niso.org/contributor-roles/project-administration/ ID: a693fe76-ea33-49ad-9dcc-5e4f3ac5f938
8. Recursos	Provisión de materiales de estudio, reactivos, materiales, pacientes, muestras de laboratorio, animales, instrumentación, recursos informáticos u otras herramientas de análisis.	https://credit.niso.org/contributor-roles/resources/ ID: ebd781f0-bf79-492c-ac21-b31b-9c3c990c

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 29-31.

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Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 29-31.

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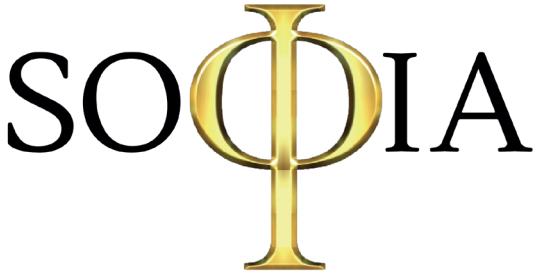

The inductive method in humanities and pedagogy

El método inductivo en las humanidades y en la pedagogía

SUMMARY / SUMARIO

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 39-40.

MISCELLANEOUS / MISCELÁNEOS

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 39-40.

Editorial

We are happy to present the 38th issue of our journal *Sophia*. The title that summarizes the diversity of approaches and perspectives is "The inductive method in the humanities and in pedagogy", a collection that invites to reflect on the transformative force of an essential methodological approach in the construction of knowledge.

With the contributions gathered in this volume, it is proposed to investigate the different ways in which the inductive method, from the observation and analysis of reality, establishes connections between facts and theories, in an adaptive and committed way with the context to promote educational practice. This issue aims to provide a space for understanding the different ways in which the humanities and pedagogy integrate inductive reasoning and open new opportunities for reflection, action, and learning.

The inductive method contributes to discovering patterns and to the construction of meanings that go from the concrete to the general. It presents as a powerful tool to rethink teaching and research in various fields of knowledge. In a global context in which educational and cultural processes must adapt to changing realities, and in which the ability to generate knowledge from experience becomes fundamental. This volume intends to provide a comprehensive theoretical vision, motivate readers to apply these methodologies in their daily practice and provide a series of categories, principles, guidelines and ideas for implementation and improvement in the academic field, as well as in the communities in which they operate.

The 38th edition of our journal explores the impact and possibilities of the inductive method in the humanities and in pedagogy, analyzing its foundations and practical applications in educational and scientific contexts.

From an experiential and reflective approach, the inductive method in the humanities and in pedagogy is pivotal since it responds to the need to demonstrate the complexity of human and social phenomena; it offers a methodological and didactic framework enriched with the implementation of observation, experience, and reflection; it favors the improvement of various research and teaching-learning processes. Its versatility and ability to adapt to contemporary demands make it a neces-

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 41-47.

sary resource to foster a more critical, inclusive, and oriented education towards social change and transformation.

This method fosters active and contextualized learning, essential qualities in a world where knowledge and education face global challenges such as disinformation, cultural diversity, and digital transformation. It promotes a situated education, focused on the understanding and articulation of theoretical-practical knowledge.

As it is generally known, the inductive method has contributed significantly to traditional scientific activity and offers interesting approaches to understanding the different phenomena of the human and social sciences. Likewise, its emphasis on experience as the primary source of knowledge resonates with contemporary needs for action-oriented, critical, and thoughtful education.

Historically, "the human being from its origins began to question himself and everything that happened around him, began to reflect and seek explanations about the causes and principles of everything" (Aguilar Gordón, 2015, p. 14), tried to find explanations from myth, legend, rite and gradually began to seek solutions from reason, experience, science, etc. To the extent that it establishes relationships between different phenomena, it implements a variety of research methods, discovers techniques and procedures ordered, systematic and coordinated that shape science from at least three perspectives, in which the following criteria predominate:

- Assessment of human reason mediated by the mathematical-deductive method.
- Assessment of experience and observation of concrete facts mediated by the inductive method initiated by Francis Bacon in the science of Modernity.
- Evaluation of experience and reason thanks to the use of the resolutive-compositional method known as hypothetical-deductive (inductivist-deductivist) initiated by Galileo.

Undoubtedly, the inductive method is essential to address current educational challenges where learning requires the inescapable balance between theory and objective-sensory praxis typical of the concrete reality in which the subject interacts. In the humanities, the method allows the interpretation of cultural, historical, and social phenomena with a contextualized and plural approach. In pedagogy, it translates into teaching strategies that prioritize the experience and participation of students, encouraging the construction of meaningful learning and the development of critical competences.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 41-47.

In addition, it is necessary to consider that the inductive method responds to a growing need to link knowledge with reality, promoting educational solutions that integrate reflection, creativity, and action.

Digital transformation, interdisciplinarity and cultural diversity as features of the social dynamics of the current context, require the presence of the inductive method in education. Thus, in educational practice, the use of methodologies such as service-learning, the discovery approach, problem-based learning, among others, is justified. All of them inspired by the principles of induction enrich the educational processes and contribute to the formation of critical, analytical, committed, and proactive citizens.

In education, the use of an inductivist methodology "enables horizontal relations between the professor and the student" (Aguilar Gordón, 2019, p. 94). Likewise, in the research process, both are seen as "active agents for constructing knowledge, and thus achieve a greater dynamization of the teaching-learning process" (p. 95). This type of methodology is used to evaluate the learning potential as a product of interaction with the context in which experience, observation, and participation play an important role. The inductive method in pedagogical practice encourages the dialog of knowledge and promotes the development of skills to learn to know", "learn to do", "learn to be and "learn to live with others", in the style of the four pillars of education, suggested in the report *Education contains a treasure,* presented to UNESCO by Jacques Delors (1996).

In pedagogy, the inductive method translates into a key tool to promote active, meaningful and observation- and experience-based learning; it promotes guided discovery, problem solving and timely decision-making. This method reinforces the need for an education that integrates experience, action, and critical thinking, and motivates the creation of a scenario in which students are active participants in the construction of knowledge. In addition, its integration with constructivist principles and participatory approaches makes it an educational resource that responds to contemporary demands for innovation and personalization of learning.

In the humanities, induction allows a methodological approach that combines analytical rigor with interpretative sensitivity, favoring an integral understanding of social and cultural phenomena. The inductive method is indispensable for interpreting sociocultural contexts and establishing connections between specific phenomena and broader theories; it becomes one of the best tools to build theories from observation and experience, interpreting human phenomena from a situated and empirical perspective.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 41-47.

Structure of Sophia 38

The 10 articles of this volume are distributed between the main theme of the call and the variety of topics related to it. All the articles demonstrate the versatility and effectiveness of the inductive method in various educational fields, from ethical training to science teaching, promoting a more reflective, dynamic, and integrated education with emerging technologies.

On the central theme

The intellectual journey begins, the article "The Role of the Inductive Method as a Link Between Educational Theories and Classroom Practices" by Luis Rodolfo López Morocho (Belgium) and Christian Paul Jaramillo Baquerizo (Ecuador), explains the role of the inductive method in linking educational theories, pedagogical models, educational research and classroom practice. It highlights the relevance of the inductive method in the improvement of teaching-learning processes.

The article "Contributions of the Inductive Method to the Teaching of Military Ethics" by Andrés Eduardo Fernández Osorio (Colombia), Marina Miron (United Kingdom) and David Whetham (United Kingdom), guides respect for human rights, the observance of the laws of war and the protection of institutional legitimacy. In this sense, military ethics presents as a fundamental tool to guide the behavior of the military in complex environments to ensure responsible decision-making and direct the attitudes and behavior of military personnel through the application of innovative methods such as the inductive method.

For its part, the manuscript "Inductive Methodologies in Education, Supported by the Integration of Technology" presented by Mexicans Magda Collazo Fuentes, María Guadalupe Veytia Bucheli and Francisco Javier Rivera Alejo, analyzes the translation and validation of the instrument developed to apply the inductive method with the SAMR model, in Spanish-speaking educational contexts to facilitate its use in teaching-learning with technology. The paper explains that inductive methodology is complemented by educational technologies to promote more interactive and evidence-based teaching. Through the application of the SAMR model it is shown that the integration of technologies facilitates the application of inductive methodologies in the classroom.

Likewise, "Induction and Analogy in Applied Ethics in Socio-Educational Projects" by the Mexicans María Teresa Yurén Camarena, Elena Guadalupe Rodríguez Roa and Miriam de la Cruz Reyes, explains the ad-

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vantages of articulating induction and analogy with the applied ethics in socio-educational projects. In this sense, the authors examine theoretical positions on the status of applied ethics, confirming that induction and analogy are present. In addition, they consider that these methodologies contribute to the improvement of learning and establish contextualized moral behavior patterns.

Finally, the article "Conceptual construction in physics through inductive teaching methods" by Julio Cuevas Romo (Mexico), discusses the application of inductive strategies for the teaching of scientific concepts of physics. The author considers that the use of didactic strategies with inductive characteristics contributes to the improvement of conceptual understanding in students of exact sciences.

About the open section (miscellaneous)

The five articles included in this section address varied content and topics, but indirectly related to the central theme of the call. Below is a brief presentation of the results.

The text that opens the way for reflection is "The erotetic approach in ecocriticism" by Dancizo Yarness Toro Rivadeneira (Spain). The author analyzes the interrelationship between the conceptual frameworks of ecology and literary critical theory; suggests a common structure based on agendas of problems that enrich scientific practice and teaching; highlights the importance of questions in environmental sciences to redefine new research agendas integrating conceptual frameworks not unified by a central theory; maintains that "ecocriticism is configured as a research program structured erotetically, just like ecology".

The article "Critical Perspective of Educational Innovation from Active Learning Methodologies" by the Spanish Romina Denise Jasso Alfieri, Vicente de Jesús Fernández Mora and Antonio Daniel García Rojas, proposes active methodologies as suitable means to implement educational innovation, which must be focused on a social approach that considers people as the fundamental center of any training process, as creators and as supporters of such innovations. The proposal is supported by fundamental aspects of educational theory, the philosophy of education and the philosophy of educational innovation.

For its part, "Contributions of the Frankfurt School and Edgar Morin to Promote Dialectical and Complex Thinking in Education", by Sheila López Pérez (Spain), outlines an educational proposal "that complexifies the way of thinking of schooled adolescents and their way of co-

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existing with uncertainty, becoming and otherness". The author considers that dialectical and complex thinking can and should be articulated to form "citizens capable of taking charge of their democracies" and asserts that it is necessary to "promote an education for complexity, understanding and freedom".

Likewise, the text "Scientific Models as Abstract Epistemic Tools for Learning how to Reason" by Juan Bautista Bengoetxea Cousillas (Spain), establishes that the philosophy of science and education have critically valued the virtues of various scientific methods, especially inductive and deductive ones. Additionally, he argues that empirical evidence-based modeling is a practice of high interest in linguistics, and he compares two philosophical approaches to scientific modeling: representational and pragmatic.

This journey of approaches and perspectives concludes with the article "Academic Challenge using Writing Virtual Tools", by Verónica Patricia Simbaña Gallardo, Lilian Mercedes Jaramillo Naranjo and Santiago Fernando Vinueza (Ecuador). Here the authors show the contribution of Scrivener and Evernote as valuable digital tools for academic writing, since they "allow to insert written notes, voice notes, abstracts, documents, images, quotes from authors, audios, links…", making this practice more efficient and systematized.

In this issue 38 of Sophia, dedicated to the "Inductive Method in the Humanities and in Pedagogy", we celebrate the richness and depth of a methodological approach that continues to transform the way we understand and practice teaching, research and learning. Through the contributions of outstanding authors, it has been explored how induction, based on the observation and interpretation of specific phenomena, allows to build theories and models that not only enrich the academic field, but also have a direct impact on the training of students and professionals committed to a more reflective and critical education but also makes an invitation to pedagogical practice, showing how the inductive method can promote a more dynamic, inclusive and adapted to the challenges of contemporary society.

We are pleased to know that the inductive method, far from being a research tool, stands as a bridge that connects knowledge with action, theories with classroom realities and reflection with praxis. In a world in constant change, where the ability to appropriate, create and learn new realities is essential, the inductive approach emerges as a source of inspiration and innovation.

We thank all authors for their valuable intellectual contribution; the reviewers of the articles for their contribution in the editorial process;

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and our readers for their continued support. We hope that this issue will generate new ideas and dialogs that will further enrich the field of the humanities and pedagogy.

Floralba del Rocío Aguilar Gordón
Editor-in-Chief

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Sophia 38: 2025.

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Articles / *Artículos*

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The Role of the Inductive Method as a Link Between Educational Theories and Classroom Practices

El rol del método inductivo como vínculo entre las teorías educativas y las prácticas de aula

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Abstract

This study addresses the issue of the relationship between theories and pedagogical models, focusing on their connection with educational research and classroom practice. In this context, the main objective is to analyze the role of the inductive method in the relationship between theories and pedagogical models from classroom praxis, using meta-research and reflective critique based on Grounded Theory. Thus, the definitions of theories and pedagogical models, the historical role of the inductive method in educational research, the relationship between inductive reasoning, the main theories and pedagogical models, and the practical implications of these approaches in teaching and learning are explored. The results reveal that the inductive method is essential for formulating hypotheses, theories, and models from empirical observations, providing a solid foundation for educational research. Additionally, it has significantly influenced the development of various pedagogical models, facilitating the integration of theory and practice, which is vital for effective teaching. In conclusion, the study highlights the ongoing relevance of the inductive method in educational research and its potential to improve pedagogical practices, especially with the advancement of technology, which offers new opportunities to enhance data collection and analysis.

Keywords

Inductive Method, Educational Theories, Pedagogical Models, Educational Research, Classroom Practice, Grounded Theory.

Resumen

Este estudio aborda la problemática en torno a la relación de las teorías y modelos pedagógicos, centrándose en su vínculo con la investigación educativa y la práctica en el aula. En este sentido, el objetivo principal es analizar el rol del método inductivo en la relación entre las teorías y modelos pedagógicos desde la praxis en el aula, utilizando la metainvestigación y la crítica reflexiva basada en la teoría fundamentada. De este modo, se exploran las definiciones de teorías y modelos pedagógicos, el rol histórico del método inductivo en la investigación educativa, la relación entre el razonamiento inductivo, las principales teorías y modelos pedagógicos, y las implicaciones prácticas de estos enfoques en la enseñanza y el aprendizaje. Los resultados revelan que el método inductivo es esencial para formular hipótesis, teorías y modelos a partir de observaciones empíricas, proporcionando una base sólida para la investigación educativa. Además, ha influido significativamente en el desarrollo de diversos modelos pedagógicos, facilitando la integración de teoría y práctica, lo cual es vital para una enseñanza efectiva. En conclusión, el estudio destaca la relevancia continua del método inductivo en la investigación educativa y su potencial para mejorar las prácticas pedagógicas, especialmente con el avance de la tecnología, que ofrece nuevas oportunidades para mejorar la recopilación y el análisis de datos.

Palabras clave

Método inductivo, teorías educativas, modelos pedagógicos, investigación educativa, práctica en el aula, teoría fundamentada.

Introduction

Everyone involved in the educational field has addressed, directly or indirectly, the different foundations of their practice. Although currently the central focus is on methodologies, both in classroom practices and research, there is an indissociable link between methods and theories. This forces the researcher to delve into the "epistemological panorama

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of pedagogy" (Prats, 2010, p. 5). This path is extremely complex and can become a real challenge that sometimes causes frustration and leads to abandonment because of its apparent uselessness. However, it is an important issue that must be addressed. Moreover, it is worth it, because as Baruch Spinoza (2007) says, "everything exalted is as difficult as it is rare" (p. 428) or as mentioned more contemporaneously, one cannot escape "the usefulness of the useless" (Ordine, 2013, p. 9).

At present, the importance of the intrinsic relationship between practice and educational theory is widely recognized. This relationship becomes even more crucial when the teaching practice combines the formative work with the investigative. As is often attributed to Kant (2005), practice without theory is blind, while theory without practice is sterile. Similarly, Freire (2006) noted that "separate from practice, theory becomes pure verbalism. Separate from theory, practice is but blind activism" (p. 30). In this way, both components are fundamental. In this sense, one of the problems faced is the disconnection between didactics and classroom methodologies with different theories, paradigms and pedagogical models (Álvarez Álvarez, 2015). This situation is paradoxical, since it is precisely the theoretical constructs that should illuminate educational practices and research (Dewey, 2004). Thus, the main problem of this work lies in determining Thus, the main problem of this work lies in determining the relationship between educational theories and pedagogical models with classroom praxis.

Thus, the main objective of this work is to analyze the role of the inductive method in the relationship with educational theories and pedagogical models from classroom praxis, using meta-research and reflexive criticism based on grounded theory. To do this, genealogy (Foucault, 1988) is used as a strategy to develop this article, seeking to trace the emergence of different theories and educational models in relation to the role of the inductive method. Therefore, the idea to defend is that the inductive method plays a central role as a link between theory and classroom practice. Through the inductive method and its processes it is possible to materialize the relationship between pedagogical models and classroom praxis, improving teaching practices and promoting meaningful learning in diverse educational contexts.

In this sense, this paper is configured in three sections. In the first, the concepts of theories and pedagogical models are analyzed, because it is necessary to understand the epistemological landscape that has historically supported the various classroom practices and educational research processes. In the second section, the meaning of the inductive method is

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

presented from its emergence to contemporaneity in relation to educational research. Finally, the relationship between the inductive method and pedagogical models is examined, as well as its impact on classroom praxis in order to establish its central role in the relationship between theory and practice.

Epistemological approach to theories and pedagogical models

There are three key concepts that need to be specified because they will be the axis of this research: theories, models and methods. This section will focus on the first two to subsequently address the concept of methods. These categories allow us to raise a series of problems regarding educational research and classroom practice, directly linked to inductive thinking. For this, it is impossible not to use the genealogical approach (Foucault, 1988) that considers the conditions of possibility, both historical and conceptual, of the conformation of these great explanatory models with different approaches, foundations, places, and times of emergence.

The term "theory" etymologically comes from the Greek *theoreo*, which means to observe or look (Mora, 2009, p. 374). In a philosophical sense, it refers to the action of contemplation or speculation. Aristotle even suggested that the highest theory is "thinking of thought." In this way, theoretical life would be understood as the proper purpose of the virtuous man, which leads to a full life. It is also often understood in opposition to the practice, with a historical dispute surrounding the relationship of these terms. This dispute can be resolved in various ways: as a counterposition, balance, harmony, fusion, among others.

Theories, in many cases, lead to conceptual systems or configurations where there is coherence, cohesion and structure. These are configured in multiple ways, necessarily seeking to establish a relationship with facts or phenomena, all from both deductive and inductive reasoning. Precisely, this link with reality makes theories mutable, contingent, and evolving. Therefore, any attempt at theoretical construction is, to a greater or lesser extent, provisional (Carvajal, 2002).

In the different fields of study, including education, theories are understood as "a set of assumptions or articulated prepositions about the social reality under study and about how to know that reality" (Sirvent, 2010, p. 130). Theories are almost always reduced to the great explanatory constructs of realities that have been consolidated in the academic and

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

scientific world, such as, in the educational case, the theories of Piaget, Vygotsky, Bourdieu, among others. However, it is important to consider that theories can also refer to the way of thinking that people are shaping throughout their lives and that guide their actions. In this second sense, theory is simply the ability of every human being to realize intellectual constructs of his daily life, i.e., to theorize.

The relationship between theory and research is emphasized in the possible usefulness of the first over the second (Hernández Sampieri *et al*., 2006). In this sense, as argued, the primary function of the theory is to explain, i.e., to show the "why", "how" and "when" of a certain phenomenon (Bryman, 2021). In addition, it allows to give order to knowledge, i.e., it leads to systematicity and, therefore, to organization (Flick, 2019). Another function, inherited from scientific vision, is to predict or, in other words, make inferences, more or less clear, of what will happen with the explained phenomena (Creswell & Creswell, 2018). Evidently, this predictive ability is much more complex in the field of human sciences than in the exact sciences (Silverman, 2020). In summary, the theory allows the researcher to describe, explain and predict all from a certain logical consistency that will become what is called the theoretical framework of research (Yin, 2020).

The theory has a direct connection to the cognitive processes of every human being. However, these processes are more important for researchers because of the very nature of their profession. Theorizing allows distancing from the objects of study, allows obtaining information and processing it through abstraction, comparison, and analysis resources (Schunk, 2012). All this leads directly into the field of methodology (Creswell & Creswell, 2018). However, before entering into the definition of this second major category, it is necessary to mention the implications of the theory in the field of pedagogical models.

Thus, scientific theories can be understood as the explanatory frameworks that have been established and validated throughout history to study, understand and explain certain phenomena and objects of study. Specifically, when defining the different macro-theoretical models of education, one of the first questions that arise are: ¿what is meant by the educational model? ¿What is the difference between a model, paradigm and theory? ¿What are the main models, paradigms, theories in the educational field? To answer these questions, it is essential to start from a brief retrospective view on the emergence of the various current models focusing on their epistemological criteria.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

When referring to terms such as "models" or "paradigm", it is necessary to approach the philosophical subdiscipline called epistemology, which can be defined (Mora, 2009) as the general theory of scientific knowledge. This discipline will be responsible for answering questions such as: what is a science?, what are the requirements that a discipline must meet to be considered scientific?, what implications does it have for a discipline to be considered science?

Answering the above questions exceeds the intentions of the present work. Therefore, for the purposes of this study, the approaches of Thomas Kuhn (1971) will be considered, moving away from the positivist views of science. As known (López, 2021), Kuhn shook the foundations of what was understood by science at the time, questioning the prevailing positivist view: "His book unleashed an authentic revolution, the effects of which are still noticeable today, in the modern philosophy of science" (Artigas, 1999, p. 85). One of its most relevant contributions is to point out that, globally, science also has a significant valuation burden. In the words of Gómez (2014), Kuhn shows "the explicit recognition of the presence of values not only in scientific activity, but also in its unit of analysis" (p. 69).

His work *The Structure of Scientific Revolutions* is central to twentieth-century science and philosophy. The central concept of this work is that of "paradigm", a term that has had a significant impact. Defining the paradigm is complex due to its multiple interpretations. According to Agamben (2008), Kuhn employs it in at least two senses. First, it refers to "what the members of a certain scientific community share in common: a set of techniques, models and values to which they adhere consciously or unconsciously" and second, to "a particular element within that set" (p. 14). Examples of paradigms include Newton's *Principle* and Ptolemy's *Almagest*, which substitute explicit rules and define a specific and coherent tradition of inquiry.

Kuhn's contributions allow, according to Chalmers (1990), to understand that science does not follow a logical trajectory of order and progress, as positivist perspectives suggest. Instead, science implies abandoning theoretical structures and replacing them with new ones that are not compatible with the old ones. Thus, the answer to the question, ¿what is science?, could be that it is a discipline that manages to establish a specific paradigm within an academic scientific community. It is important to note that Kuhn's ideas are not perfect, for example, "the decisions and choices of scientists or groups of scientists are influenced by the values of these individuals or groups" (p. 145).

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

As seen, the epistemological dimension of the concept "paradigm" or "model" refers "to the general conditions of production of scientific knowledge" (Sirvent, 2010, p. 141). These models, in turn, produce research logics that involve the specific production conditions of the research. Finally, these frameworks translate into methodological procedures that determine how each researcher relates theory and practice to the object of their research. However, these general frameworks debates arise around the so-called logical pairs or suppositional modes (p. 144). These mark different ideas in the multiplicity of epistemological approaches or perspectives, for example: deduction-induction, verification-generation, explanation-understanding, objectivity-subjectivity, among others.

This work focuses on the deduction-induction axis, which is explored in the following section. It is important to mention that this axis refers to the classic dispute between the processes of deductive reasoning, closely linked to an abstraction that goes from the general to the particular (decreasing abstraction), and inductive reasoning, characterized by an abstraction that goes from the particular to the general (increasing abstraction). In any case, these theoretical decisions will translate into methodological decisions that the researcher makes in his daily life and will emphasize in certain axes of the aforementioned. It is therefore necessary to address the problem of the method as it directly involves the organization and sequence of steps that seek to ensure the scientific production of knowledge.

Methods and inductive thinking in educational research processes

To approach the role of inductive method in the field of educational research, it is necessary to enter the field of metaresearch, which can be defined as "research research" (Mainardes, 2018) or also as the study of the research itself and specifically of its methods, incentives, reports, reproducibility and evaluation, among others (Loannidis, 2018). Among all these possibilities, the center of reflection will be on the relationship between method and theory in the field of educational research.

Research in the field of education is a diverse, multidisciplinary and complex space (Aguilar Gordón, 2010) that relies on disciplines such as psychology (Bandura, 1987; Brunner, 1984; Piaget, 2016; Vygotsky, 1962), sociology (Bourdieu & Passeron, 2007; Durkheim, 1973) and philosophy (Dewey, 2004; Rousseau, 2008), among others. This has led to multiple

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

approaches from diverse schools, traditions and approaches. This characteristic has also made the field of education scattered and with a complex definition to limit, making it difficult to regulate it in the intellectual field (Sánchez Tortosa, 2018). In fact, research in the educational field has been nourished by different theoretical frameworks such as phenomenology, positivism, hermeneutics, structuralism, constructivism, among other currents, each with its own interpretative frameworks. In the second half of the 20th century these have been grouped into qualitative and quantitative approaches (Hernández Sampieri *et al*., 2006). And these, in turn, have led to so-called mixed approaches.

What is interesting in this paper is to explain the methodological dimension of the pedagogical models and show what is the current role of the inductive method in each of them. To this end, it is important to briefly recall what is referred to when talking about method in the field of research. Its etymology refers to the meaning of road (Mora, 2009). Therefore, it is the means to achieve a certain end, for Plato it was to seek the best way to achieve knowledge, this was a similar understanding for Aristotle. Thus, the method must be understood as a random contrast, since it has a manifest order and, therefore, a series of rules that regulate the processes and criteria for its acceptance and application.

This leads to the problem between the method and the reality to which it approaches, since, for many, the reality that is aspired to know determines the structure of the method (Mora, 2009). Thus, the method for knowing educational facts or phenomena will not be the same as the method used to know mathematical or physical reality, for example. Thus, the possibility of using inappropriate methods for certain objects of study is raised (Kuhn, 1971). In this same line, there has also been the dream of finding a kind of universal method to know all possible realities, a question that has been proven as unattainable by authors such as Feyerabend.

Regardless of the conception of the method, there is a common characteristic pointed out by Descartes (Mora, 2009), who states that any method must be accessible and applicable by anyone at any time. In other words, the method does not strictly depend on the intellectual abilities of the researcher. Likewise, it is also necessary to mention the classic distinction between method and demonstration. While the former seeks to find the true propositions, the latter seeks to find the reasons why a proposition can be considered true. Descartes mentioned that he sought to "drive reason and seek truth in the sciences", two elements that have

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

permeated the contemporary views of research processes in all fields (Mora, 2009).

A brief retrospective view of the inductive method

Two different types of methods can be found within the methodological taxonomies: those that can be called general and those that we call specific. The former refers to processes such as synthesis, analysis, induction, and deduction, while the latter are established by virtue of the object of study and vary enormously from discipline to discipline (Mora, 2009). Special emphasis will be made on what can be called *inductive method*. To do this, it is necessary to establish what is meant by induction. This term, according to Mora (2009), was used by Plato in his famous dialogs associated with meanings such as inducing, leading to, and directing. However, his association with the field of reasoning did not occur until Aristotle, who in his famous approaches to logic understood it as the passage from the particular to the general, as opposed to syllogism, which was the passage from the general to the particular. This view similarly permeated scholastic thought in the Middle Ages.

In the Modern Age, philosophers interested mainly in the field of natural sciences embarked on reflections on inductive processes, such as Francis Bacon, who questioned these processes as being "incomplete enumerations" (Mora, 2009). Instead, Bacon worked out processes such as absence and presence tables to ensure legitimate inductions. In fact, his approaches marked important influences until the 19th century in currents such as empiricism (Locke, 1690), Aristotelian scholastic ideas (Copleston, 1993), in rationalists such as Leibniz (1989) and even Hume (1980) argued that induction is based on habit and Kant himself (2005) in inductive judgments.

After the nineteenth century, there was an explosion of paths in the approaches of induction, there stands out Gratry (1855), who considered it as an equivalent to the dialectic that allows us to move to the "other". John Stuart Mill (1894), meanwhile, developed a system of inductive logic. Peirce (1878) and Lachelier (1904) focused on the so-called problem about the basis of induction. Lalande (1922) argues that there are several types of induction, on the one hand, there is the general induction, which refers to the operation by which a certain conclusion is reached on a fact that in turn starts from another fact. This type of induction is called reconstructive and is the same that doctors use to diagnose a disease from the symptoms or also in the field of jurisprudence, with the so-called le-

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

gal tests; on the other hand, the strict concept of induction refers to the processes of reasoning that start from particular cases to reach general conclusions, such as the passage of facts to the laws or from the specific to the general. This type of induction is in turn classified into two types: ordinary or amplified induction and formal or complete induction (Mora, 2009). The first refers to the experimental test worked by philosophers such as Stuart Mill (1984), i.e., to enunciate a universal judgment on a series of objects limited to the same subject and predicate; the second corresponds to Aristotelian syllogism based on complete enumerations, where a property is expressed in a single formula that has been individually affirmed for each member of a set or class.

For Nelson Goodman (1954), the problems of induction can be grouped into two major periods: the old problem of induction and the new riddle of induction. The first has been widely discussed in the 19th century and, in essence, refers to the problem of the justification of induction or, in other words, of the validity of inductive inferences. One of the possible answers is the law of universal causation, according to which induction is justified in the law of uniformity of nature, which states that, if two examples coincide in certain aspects, they will also do so in all others. Hume (1980) addresses this problem by suggesting that what is relevant is not how predictions are justified, but why they are generated in the first place. This position has been criticized for its psychological or genetic emphasis, which researchers in this field have dismissed.

At present, in what Goodman (1954) has called "the new riddle of induction", the problems around induction and inductive reasoning have led to two main lines: that of confirmation and that of probability (Mora, 2009). As for the question of probability-related induction, there are essentially two opposite currents. The one represented by Mises (1957) and Reichenbach (1949) argues that the problem of induction must be approached from the perspective of the frequency theory of probability, since inductive inferences are transformed into statistical inferences. On the contrary, for the school represented by philosophers such as Carnap (1969), Hempel (1965) or Goodman (1954), the problem of induction must be treated from probability understood as degrees of confirmation; therefore, the central notion would be precisely that of confirmation. Within these two competing schools, philosophers such as Leblanc (1983) have attempted to mediate between these two poles.

As seen, in the field of educational research, the debate on the inductive has had historical transitions that have ranged from the premises of logical reasoning to the debate around its nature in the field of science.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

In any case, they have blurred into different theoretical models that have finally been grouped into quantitative, qualitative and mixed approaches. However, the presence of the inductive not only manifests itself in the field of research, it also presents a strong influence associated with the different theories and pedagogical models that will be analyzed below.

Pedagogical theories and models from behaviorism to connectivism

Considering the epistemological basis outlined above, it is necessary to mention the taxonomy or classification criterion that will be used to list the theories and pedagogical models, while transversely showing the role of the inductive in them. First, it is worth remembering that to make a taxonomy, in general terms, it needs a classification scheme that takes into account a series of determined variables that are relevant to the object of study: "This classification attempt forces to find categories or noun groups clearly defined, and the more singular the one from the others the better, so that the classification is also integrative and coherent" (Prats, 2010, p. 7). In this way, the theoretical currents that we have chosen are: behaviorism, cognitivism, constructivism, humanism and connectivism. These have been considered for their wide presence in the contemporary vision of education, since in the 21st century they are still present in different educational policies and practices worldwide.

The Eternal Return of Behaviorism

Behaviorism (Ortiz, 2013) maintained a hegemony during the first half of the 20th century. In simple terms, its conception of learning is based on the stimulus-response partnership. The studies began with animals: the dog in Pavlov's case (1927) and the dove in Skinner's case (1938). These experiments led to the hypothesis that a certain response to a certain stimulus can be conditioned. The key to making this partnership work is in repetition, adding different types of reinforcement. For Gallardo and Camacho (2008), behaviorism—or more precisely the theories of conditioning—does not present a single aspect. On the contrary, there are at least two variants: the classical conditioning represented by Pavlov (1927) and the operant conditioning, whose most famous exponent is Skinner (1938). Special mention is given to Thorndike (1913), who can be considered the first psychologist of education who developed a theory of conditioning applied to learning.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

In the 20th century, in the field of psychology, the two most "important currents of thought were structuralism and functionalism" (Schunk, 2012, p. 71). In a context in which the discipline sought its consolidation by moving towards more scientific and experimental approaches, the contributions of behaviorism emerge, which became "the main psychological discipline" (p. 72). Watson (1924) founded modern behaviorism, following a model in psychology that resembled that of the physical sciences, working with observable and measurable phenomena. This approach focused on behavior, moving away from the introspective views of structuralism and overly general views of functionalism.

Pavlov (1932), for his part, represents the theory of classical conditioning, which focuses on "the presentation of an unconditioned stimulus, which provokes an unconditioned response" (Schunk, 2012, p. 79). Pavlov argued that any stimulus could be conditioned to produce any response, although later research showed that it is not always feasible to generalize the conditioning process. Subsequently, Skinner's celebrated theory of operant conditioning (1938) went from experimenting only with animals to testing with humans. The principles of his theory are based on functional analysis of behavior and highlight the implications for prediction and control of behavior. Behavioral theory became complex, including a number of basic processes such as positive reinforcement, negative reinforcement, and punishment.

The role of the inductive method in behavioral theories is centered on the processes of observing specific behaviors of subjects and formulating generalizations from them. These are relevant elements to understand how different stimuli and responses can generate changes in the behaviors of these individuals. The limitation lies in equating the human being with a machine, assuming that their behaviors can be modified and predicted by the application of specific stimuli and responses. Although behavioral approaches are not very popular in the theoretical field and there are few defenses due to the existence of more current and complex theories, many of their premises are still alive in practice. Therefore, "the disappearance of a behavioral theory did not mean the disappearance of behaviorism" (Peña, 2010, p. 130). In this sense, it is important to mention that "the contributions of neobehaviorism, like other learning psychologies, can provide necessary ideas for innovation and the construction of teaching and virtual learning" (Gros, 2007, p. 247).

In a specific classroom example, if the teacher wishes to promote reading habits in their students using behavioral principles and the inductive method, they can start by establishing a reward system. Every

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

time a student completes a book and shares a brief review with the class, they receive a gold star on a collective mural. Without initially explaining the purpose of the mural or the stars, the teacher watches as some students begin to participate in order to obtain the visible reward. As more students see their peers receive stars and awards, they are motivated to imitate them. The teacher positively reinforces these behaviors through praise and small additional rewards, such as extra time in playful activities. Through the observation of these specific experiences and the associated positive consequences, students induce that reading and participation provide them with benefits, both individual and collective. Without needing to explain in an abstract way the importance of reading, students internalize this habit thanks to operant conditioning—a key principle of behaviorism—and the inductive process of generalizing from concrete examples and behaviors, as will be explained later also by the concept of "modeling" of Bandura (1987) and the direct reinforcements in the classroom environment.

Behavioral theories, as already mentioned, had hegemony during the middle of the 20th century. However, since the beginning of the 1950s and 1960s, these theories have been questioned, gradually reducing their validity and giving way to cognitive cutting theories. For these theories, on the other hand, "mental activities such as attention, expectations, thought and remembrance as crucial to learning processes" are important (Morris & Maisto, 2005, p. 173).

The Diffuse Boundaries Between Cognitivism and Constructivism

Regarding the onset of cognitive currents, there are a number of problems to frame them precisely, as there are multiple nuances, however, we can say that: "we did not need to exhibit our learning for this to occur. Tolman called learning latent to learning that is not apparent because it is not yet demonstrated" (Morris & Maisto, 2005, p. 173). One of the phenomena that highlights the importance of cognitive processes is the so-called *insights*, which refer to the integration of the elements of a situation. Thus, Albert Bandura (1987) raises one of the first criticisms of behaviorism through his studies that showed how "people could learn new actions by simply observing others perform them" (Schunk, 2012, p. 118). Bandura is framed in social cognitivist theories, which posit that human learning occurs within a social environment. From the epistemological point of view, this aspect is responsible for distinguishing between new learning and the performance of previously learned behaviors.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

Thus, Bandura proposes learning by observation or vicarious (Morris & Maisto, 2005), which states that learning through modeling occurs when observers acquire new patterns of behavior, even before they have been directly exposed to such modeled behaviors. This repeats behaviors that we have observed, although this does not mean that we more often imitate those that are rewarded. One of the most influential are the theories of information processing (Schunk, 2012), which focus on how people pay attention to environmental events, encode information, associate it, store it in memory and recover it, among other processes. Within this nomination coexist several theories where there is not necessarily a predominance of one over another, however, special mention requires the theory of the Gestalt.

The inductive method plays a relevant role in cognitivism, as these theories are developed from observation and detailed analysis of mental processes. Specific situations are observed, patterns are identified, and generalizations are formulated about how people process information. The theory of the Gestalt (Schunk, 2012), for example, is based on the observation of how people perceive and organize the elements in their environment, concluding that perception is an integral process in which the whole has a greater value than the simple addition of its components.

In fact, the word Gestalt, which gives its name to this theory, literally means "form", "figure" or "configuration" and collects the essence of their psychological approaches that maintain that objects or events are perceived as an organized whole. The meaning arises from the general configuration and not from the individual parts. In simple words, a tree, for example, is not the set of roots, trunk, leaves and branches, but the configuration with meaning of all these elements. The human being is not limited to the capture of the parts, but to the whole. The brain creates totalities with meaning.

Perhaps it could be argued that cognitivism is a transit from behaviorism to constructivism, hence its difficulties in defining it and specifying it by its multiple nuances. In any case, this path leads to one of the most influential theorists of education during the 20th century, Jean Piaget. The approaches of this thinker have had an unquantifiable impact on education, both in theory and in pedagogical practice, not in vain "the name of Piaget is one of the most frequently mentioned in pedagogical publications" (Fairstein & Carretero, 2007, p. 178).

Jean Piaget (2016) is usually part of what has now been called a constructivist perspective or conception. However, the most accurate way to refer to its conceptual framework would be as "genetic psychology"

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

(Fairstein & Carretero, 2007, p. 179). Today, constructivism is difficult to define, as it is not limited to a single psychological theory, but is a convergence of multiple theories. In this context, it is possible to distinguish three types of constructivism: epistemological, psychological and educational. Regarding Piaget's theory, the main focus of his theoretical corpus was not initially oriented from a psychological perspective, his main interest was epistemological in nature (Fairstein & Carretero, 2007). In other words, Piaget did not focus on child development itself, but rather its issues were more philosophical, specifically related to the theory of knowledge, where psychological research acted as a simple means. It was from these interests that he began to explore how knowledge and intelligence develop in people from birth to adulthood.

Genetic psychology (Piaget, 2016) considers cognitive development as an increase in the human being's abilities to predict, explain and understand the world around them. Therefore, behavior is considered to be the result of mental representations. Thus, "the subject of genetic psychology is an active constructor of meanings" and "Piaget theory conceives learning as a process of adapting the mental structures of the subject to his environment" (Fairstein & Carretero, 2007, p. 182). This adaptation occurs through two processes: assimilation and accommodation. Surely the contribution that has transcended the most throughout history are the famous stages of cognitive development of Piaget. These stages or evolutionary stages (Gallardo & Camacho, 2008) are continuous and should not be progressively transited, i.e., it is not possible to omit one in the development of the child.

The final theory Piaget worked on until his death was that of balancing (Fairstein & Carretero, 2007). In this theory, Piaget refers to the mechanisms that allow the individual to move from one scheme to another at a higher level. With this contribution, he completed his explanation of adaptation theory. In this way, the process of equilibrium is formed by the logic of equilibrium-conflict-new equilibrium. Piagetian theories, as already mentioned above, have exerted a radical influence on later educational theories and practices. The applications of genetic psychology (Fairstein & Carretero, 2007) can be grouped into pedagogical proposals and psychopedagogical research. The first refer to the application of Piagetian theory in the creation of educational programs, teaching methods, teaching strategies and other related aspects. The second, on the other hand, consists of studies in which Piagetian conceptions serve as the basis for conducting research on certain aspects of the teaching and learning

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

processes and are not necessarily shaped as proposals for direct application in education.

From cognitivism to constructivism

The inductive method is also fundamental in constructivism. Educators and psychologists look at children's cognitive development and interactions in various situations and then extract general principles about how knowledge is constructed. For example, Piaget used detailed observation of his own children and other children to formulate his theories about the stages of cognitive development. This inductive approach allows researchers and educators to develop pedagogical strategies based on how students actually learn and understand the world around them.

Along with Piaget (2016), the great theorist associated with current constructivism is Lev Vygotsky (1962), who shows the importance of "social interactions that allow to organize the activity of the apprentice" (Vila, 2007, p. 207). His theory emphasizes the importance of the social environment for learning and development. Despite Vygotsky's short life, he made a great intellectual projection (Vila, 2007), organized on two fronts: developing a scientific psychology and creating a set of techniques oriented to various aspects of human life. His psychological work had a strong impact on the educational field.

For Vygotsky, the genetic method cannot be limited to orthogenesis; on the contrary, understanding human behavior requires an understanding of three different domains: species evolution, cultural evolution, and ontogenetic development. His early studies were focused on *knowing the origin and development of consciousness.* Thus, in his work *Thought and Language* (Vygotsky, 1962), he explains the process of internalizing language as the main means of human consciousness. And this process has a social origin by emerging only in relation to others. In the pedagogical field, the approaches of Vygotsky (1962) imply that human development and teaching-learning processes are interdependent. These ideas lead to the concept of the "zone of near development" (Vila, 2007, p. 223), which refers to the existing relationships between the psychological social functioning and the individual functioning of the mind, i.e., the relationship with others and with yourself. These elements show the existence of a real evolutionary level understood as that which a person is able to do by himself, and a potential evolutionary level which is defined as that which a person can do with the help of another. The area of near development is therefore the distance between the second and the first.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

Vygotsky's ideas today are being taken up and worked on enthusiastically. At present, educational innovation seems to have focused more on Vygotsky, not in vain the contributions of Bruner, Cole and Wertsch have received a strong influence from his figure. Among them, the most famous is undoubtedly Jerome Bruner, with his learning by discovery (Schunk, 2012, p. 266), which implies the ability to train by discovering problems from the students with a minimum of guidance from teachers. Here, the idea of "active student" (Ortiz, 2013, p. 13) that needs the creation of didactic experiences that contribute to these experiences begins to be clearly visible.

Bruner, along with David Ausubel, are part of the later constructivism and although they are present in several pedagogical currents, their influence is not pure (Ortiz, 2013). Thus, for example, the Ausubel's approaches are known as "significant learning theory" (Gallardo & Camacho, 2008, p. 44), which affirm that the student's learning depends on the previous cognitive structure and its relationship with the information acquired. In other words, "meaningful" learning can be called when new information is in contact with concepts previously acquired by the student.

The inductive method is evident in Ausubel's constructivism, since it is based on observing how students integrate new information with their previous knowledge and then generalize about the best pedagogical practices to facilitate this process. This approach allows educators to develop strategies that are tailored to the individual needs of students, promoting deep learning. For example, in a high school history class, the teacher may seek to get students to understand the causes of the French Revolution, but instead of explaining the causes in a master lesson, he divides students into groups and provides each with a variety of resources (excerpts from historical documents, letters, period illustrations, economic statistics, and personal testimonies) that students analyze, discuss with each other, and observe, under the teacher's guidance. They identify patterns such as social inequality, the financial crisis, and enlightened ideas. Through this process, they induce the main causes that led to the outbreak of the Revolution. This approach allows students to actively build their knowledge, applying the inductive method by drawing general conclusions from specific data, and exemplifies constructivism by encouraging meaningful learning based on exploration and collaboration.

On constructivism, until the 21st century, it could be spoken in detail, however, being "very broad and varied" (Ortiz, 2013, p. 30) we cannot analyze all its manifestations and lines in detail. It can be said vaguely that it rescues the cognitive aspects that are based on learning, these are mediators of behavior, also producing behavioral changes. Likewise, cons-

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

tructivists postulate the need for methods of natural experimentation (Ortiz, 2013). This current houses a huge number of theoretical constructs in which sometimes humanist theory is usually included, which for some "is largely constructivist" (Schunk, 2012). However, given its specificity, it will be analyzed in a particular way.

Humanist theories and their quest to integrate cognition, emotion and choice

Humanist theories (Schunk, 2012) emphasize cognitive and emotional processes, focusing on people's abilities to make decisions and aspire to control their own lives. Among the assumptions made by these theories is the holistic view of reality, bringing together categories such as "behavior," "thought," and "feeling." For this perspective, human decisions, creativity and self-realization are fundamental aspects of study that must be valued and incorporated. In this sense, one cannot start from animal studies to extrapolate them to human beings, who are much more complex entities.

One of the most relevant contributions of these theories would surely be that made by Maslow, for whom the actions of people are guided by their goals or objectives. In this sense, human actions represent an effort to satisfy needs, which in turn are structured in a hierarchy (physiological, security, belonging, esteem and self-realization). This hierarchy has implications for teaching-learning processes (Schunk, 2012). For example, it is useful for teachers to be able to understand students in a comprehensive way, creating environments that facilitate learning. As known, it is not entirely feasible for students to devote all their effort to study if they have not met the first needs of their pyramid (physiological or safety), i.e., students who have not fed properly, who find themselves in a difficult socioeconomic position, etc.

Likewise Carl Rogers' thought centered on "realization" posited that life is constituted as a process of continuous personal growth. This natural tendency is the basis of motivation, from which absolutely all others of lesser significance are derived. Thus, personal growth is understood as achieving autonomy and, therefore, greater degrees of freedom from external forces (Schunk, 2012). Applied to the educational field, this means that the human being has in itself a power for learning nourished by desire. In other words, students know that learning is relevant because they are convinced that this will help them grow, improve. Therefore, the role of the teacher is that of a facilitator of learning and its duty is to create environments for students to achieve their goals.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

In general, humanistic theories focus on motivation for achievement (Schunk, 2012, p. 360), with numerous applications in teaching-learning processes. There are many avenues for motivation, for example, transmitting optimistic expectations to students and structuring activities in a gradual way that prevents them from being discouraged by the complexity of the challenge posed. The great contributions of these currents show us their holistic approach, which must consider both the cognitive and affective components, and within the latter the motivational ones. Therefore, for students to achieve academic success and optimal learning outcomes requires both willingness and skill (Gallardo & Camacho, 2008).

For example, in a cultural and artistic education class, if the teacher seeks to promote the personal development and self-realization of students by applying fundamentals of humanist theories, he can propose to his students to create a work of art that represents their emotions and personal experiences without providing specific instructions or role models. Thus, when students work on the development of their projects, they freely explore their feelings and thoughts, reflecting on them in their creations. This can be complemented by the presentation of the works to their classmates explaining their expressions and meanings. This activity allows to induce general concepts about the diversity of human experiences, the value of respect, empathy and self-expression. This example is not intended to suggest that, when applying motivational methods, a structure is dispensed with; on the contrary, the structure is fundamental in learning scenarios to motivate the student and allow him to relate freely and consciously to educational activities (Reeve & Cheon, 2021).

Connectivism in the Digital Age

Connectivism takes for its foundation elements of complexity theory. According to Pérez Gómez (2012):

> It assumes the current version of constructivism when taking into account the unlimited digital context of human exchanges. It emphasizes that the learning scenarios are available to all, offering unsuspected learning opportunities, and represent the endless telematic networks of accumulation, exchange and permanent creation of information and knowledge (p. 15).

In connectivism, context plays an essential role, as teaching-learning processes focus on developing connections within knowledge networks, which determines the "what" and "how" of learning. It is not only

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

about memorizing data or concepts, but also about knowing how to locate, build and maintain these connections to recreate and apply knowledge dynamically through networks (Pérez Gómez, 2012). This does not imply an environmental reductionism, since the key is precisely in the relationship between contents and contexts; it is more about assimilation processes than acquisition, recreated jointly in the networks in which the individual participates (Pérez Gómez, 2012).

In the 21st century, new technologies and digitalization have greatly improved the collection and analysis of educational data. Moreover, tools like artificial intelligence have been able to identify patterns and trends that could go unnoticed with traditional methods of data analysis. All this contributes to facilitate the understanding of educational processes and the corresponding development of pedagogical strategies based on proven information (Pérez Gómez, 2012).

In the field of educational practice, the inductive method can be applied within the frameworks of connectivism by generating learning processes where technologies and information networks are used for developing various competences (Pérez Gómez, 2012). For example, in a citizenship education class, the teacher may propose students to explore the impact of social media on communication. To do this, students must connect with various online platforms, such as blogs, podcasts, forums, or virtual communities. Students, individually or in groups, can participate in online discussions, follow experts on the subject and share information through their own social networks. As they collect data and experiences from these interactions, they must infer patterns about how social media influences the way people communicate, inform, and relate. Using the inductive method, students draw general conclusions from their specific observations. Among their findings, social media can be inferred to facilitate the rapid dissemination of information, but it can also spread disinformation.

This process reflects the practical application of connectivism, where learning occurs through connections in a network and knowledge that is distributed among various sources and accessed through participation in digital communities. Students build their own knowledge by navigating and managing information in a technological environment, applying the inductive method to generate deep understandings from real online experiences (Pérez Gómez, 2012).

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

Conclusions

This paper argues the importance of the inductive method in the relationship between theories and pedagogical models from classroom praxis, using meta-research and reflexive criticism from grounded theory. Throughout the analysis, it has been evidenced how inductive thinking allows researchers to formulate hypotheses and develop theories from empirical observations, providing a solid basis for understanding and improving teaching and learning processes. In turn, these theories are enriched from classroom practice.

The inductive method has been key in the evolution of various pedagogical theories, from behaviorism to connectivism. In the context of behaviorism, the observation of specific behaviors has allowed to identify general principles on the stimulus-response relationship, establishing a mechanical understanding of learning. In the realm of cognitivism and constructivism, the observation and detailed analysis of mental processes have led to a deeper understanding of how students process information and build knowledge. Connectivism, for its part, has taken advantage of inductive observations about digital interactions and networked learning, adapting these ideas to the age of information and technology.

One of the conclusions of this work is the reaffirmation of the need to integrate theory and practice in the educational field. The inductive method acts as an essential bridge between the two, allowing empirical observations to not only inform theoretical development but also guide pedagogical practices. This integration is relevant to ensure that educational practices are effective and based on sound principles and empirical evidence.

Despite its benefits, the inductive method also presents challenges, especially in terms of the validity and reliability of generalizations derived from specific observations. However, digitalization and advanced technologies offer new opportunities to improve the collection and analysis of educational data, enhancing the use of inductive reasoning. Researchers and educators are called upon to explore new ways of applying this method to address the complexities of contemporary education.

In summary, the study highlights the continued relevance of the inductive method as an element that allows to link classroom praxis and pedagogical theoretical models. Thus, it is possible to improve teaching-learning processes, adapting to the changing needs of students and taking advantage of the opportunities offered by technologies in new contexts. The inductive methodology, therefore, remains essential to continue innovating and improving pedagogical practices in the 21st century.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

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Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

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Contributions of the Inductive Method to the Teaching of Military Ethics

Aportes del método inductivo a la enseñanza de la ética militar

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Index h: 11

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Index h: 8

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Index h: 15

Abstract

The ethical training of military forces is essential for democracy as it guides respect for human rights, observance of the laws of war, and protection of institutional legitimacy. For this reason, military ethics has become a crucial tool to guide the behavior of the military in complex environments and ensure responsible decision-making. In this context, this article evaluates the impact of the Basic Concepts in Military Ethics course and its inductive approach on the attitudes and behaviors of Colombian military personnel. Using a quantitative methodology, a study was conducted with 230 course participants at the General Rafael Reyes Prieto Higher War School in Colombia to measure attitudes about military ethics, rules of engagement, and operational effectiveness. The main results identified that the course positively impacted the participants' attitudes about the importance of military ethics, its contribution to unit cohesion, and its influence on responsible decision-making. It is concluded that training in military ethics, through innovative methods such as inductive, prepares the military to face the challenges of today's world and responsibly fulfill their mission.

Keywords

Ethics, Inductive, Method, Learning, Military Forces, Teaching.

Resumen

La formación ética de las fuerzas militares es esencial para la democracia, pues orienta el respeto por los derEcos humanos, la observancia de las leyes de la guerra y la protección de la legitimidad institucional. Por tal motivo, la ética militar se convierte en una herramienta crucial para guiar el comportamiento de los militares en entornos complejos y garantizar la toma de decisiones responsables. En ese contexto, este artículo evalúa el impacto del curso Conceptos Básicos en Ética Militar y su enfoque inductivo en las actitudes y comportamientos del personal militar colombiano. A través de una metodología con un enfoque cuantitativo, se realizó un estudio con 230 participantes del curso en la Escuela Superior de Guerra General Rafael Reyes Prieto (ESDEG) de Colombia, para medir las actitudes sobre la ética militar, las reglas de enfrentamiento (RE) y la efectividad operacional. Dentro de los principales resultados se identificó que el curso tuvo un impacto positivo en las actitudes de los participantes sobre la importancia de la ética militar, su contribución a la cohesión de las unidades y su influencia en la toma de decisiones responsables. Se concluye que la formación en ética militar, a través de métodos innovadores como el inductivo, prepara a los militares para enfrentar los desafíos del mundo actual y garantizar el cumplimiento de su misión de manera responsable.

Palabras clave

Aprendizaje, enseñanza, ética, fuerzas militares, método, inductivo.

Introduction

Ethics, as a philosophical discipline that deals with reflecting on human morality, seeks to examine the universal principles that guide the behavior of people in society. These principles, such as justice, equity, and solidarity, are grounded in reason and provide a framework for examining human behavior.

This leads to ethics encompassing several philosophical frameworks that seek to define and justify moral precepts (Horner, 2003),

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

which can be considered as a fundamental element in decision-making processes, professional behavior and the functioning of public institutions (Bradley, 2023; Treviño *et al*., 2006). In this way, it seeks to guide individuals and societies in the pursuit of the common good.

Complementarily, applied ethics focuses on the practical use of ethical theories on specific issues and everyday scenarios, so that it guides individuals and organizations in making decisions that align with moral values while facing complex situations (Bowen, 2004). By addressing the dilemmas that arise in complex professional domains, where individuals have a great responsibility in decision-making, applied ethics projects the general principles of ethics to concrete and specific scenarios. In this regard, Cortina (1966) argues that "it is practical philosophy, and specifically ethics or moral philosophy, which puts the greatest effort into being applied, in guiding the action and decisions of human beings" (p. 119). Applied ethics, rather than posing abstract questions about the nature of good and evil, deals with solving practical moral problems that arise in various areas of human life. Although applied ethics is a specialized discipline, like everyday morals, it seeks to provide practical guidelines for decision-making in specific situations (Cortina, 1996).

This is the case with military ethics, which, as a specialized form of applied ethics, examines the principles and moral standards that govern the conduct of military personnel. In this way, it addresses unique challenges faced by the military, such as the ethical implications of war, the treatment of combatants and non-combatants, and the responsibilities of soldiers in combat situations (Jokic, 2017; Sucharov, 2005).

While the military provides institutional guidance to its personnel in dealing with critical situations, the unpredictable nature of human behavior in overwhelming circumstances underscores the need for specific training in military ethics. For this reason, the use of innovative instructional techniques, such as the inductive method and its application in education, is especially important when dealing with complex issues such as military ethics. The inductive method effectively contributes to improving the relevant problem-solving skills of military personnel in their future roles and responsibilities by integrating classroom exercises with real-life challenges.

Despite its importance, the teaching of military ethics is often limited to the context analysis of just war theory, which values moral justification for engaging in war and ethical conduct during war (Jennings & Hannah, 2011). In addition, it restricts itself to the analysis of leadership and motivation, so that military personnel are encouraged to follow

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

exemplary behavior through compliance with established rules. This approach is problematic because, although it provides standards of conduct, it does not evaluate the effects that military ethics teaching processes have and the applicability of their contents in the fulfillment of military tasks. Similarly, the teaching of military ethics is marked by scenarios of complexity, where, as Joaqui Robles and Ortiz Granja (2020) suggest, "new schemes must be developed that drive the evolution of each human being in all its potential and of the human species in its entirety" (p. 176).

Given this context, the objective of this article is to examine the results of the Basic Concepts in Military Ethics course, offered by the Military Ethics Center of King's College London (KCL) for students of the General Rafael Reyes Prieto War College (ESDEG) in the city of Bogotá, Colombia, during 2023. The research argues that an education in military ethics, such as that offered by KCL, which covers real issues and dilemmas of the military forces using novel tools and didactic resources, positively contributes to the attitude of the uniformed about the importance of military ethics, its contribution to improve the cohesion of military units, the relationship with the rules of engagement (RE), the influence on military effectiveness and the use of force, and their professional behavior.

This research is important for the strengthening of the military forces and democracy, especially in light of the current conflict, for various aspects. First, it helps to ensure compliance with international humanitarian law, understood as a set of rules that seek to limit human suffering in armed conflict and protect civilians. Second, it strengthens the legitimacy of military actions in the eyes of national and international public opinion, which builds trust in the armed institutions. Finally, it helps to promote an organizational culture based on respect for human rights, justice and equity, in such a way that it contributes to improving the internal cohesion of the military forces and preventing inappropriate behavior.

The study used a quantitative methodology, in which a structured questionnaire was applied, and the statistical analysis of a sample composed of 230 officers of the Colombian military forces was carried out. A positivist approach was used to obtain objective measurements, which are presented distributed in five sections: the first analyzes the importance of teaching military ethics; the second presents the methodology of the study carried out; the third discusses the application of the inductive method in the teaching of military ethics; the fourth describes and discusses the results of the research; the last section presents some conclusions as a starting point for new studies.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

Importance of teaching military ethics

Authors such as Aguilar Gordón (2008) argue that education is a process of self-training that empowers the individual to act autonomously and responsibly. By developing skills and knowledge, education allows people to interpret the world and make informed decisions, while ethics provides the framework of values for this action. In a complementary way, Touriñán López (2022) suggests that educational training always seeks a balance between preserving the valuable of the past (tradition) and adapting to new needs (innovation), in addition, it fosters personal development and promotes a broader vision of society.

In this sense, having ethically military personnel is a fundamental need that transcends traditional strategies to defeat the adversary and fulfill the institutional mission. Given that the military profession, by its nature, involves the use of lethal force and decision-making that can have far-reaching consequences, ethics assume crucial relevance for the protection of life.

Military forces composed of individuals with a deep sense of ethics and morals not only ensure compliance with international and national standards, but also contribute to the legitimacy of military institutions and the trust of civil society. Moreover, a strong sense of ethics helps prevent abuses of power, ensuring that the military respects the human rights of all individuals, including enemies. This attitude is not only a moral imperative, but also contributes to the effectiveness of military missions by facilitating cooperation with other military forces and strengthening international alliances.

In particular, military ethics are not limited to the prohibition of reprehensible conduct and actions, but also involve the promotion of positive values, such as honor, duty, and loyalty. These values are fundamental to the development of a strong moral character in the military, enabling them to make difficult decisions in complex situations and fulfill their duty to protect their nation.

Specifically, military ethics focuses on analyzing the appropriate behavior and actions of soldiers, for which it encompasses fundamental principles and values, the role of the military in society and the development of the individual (Baumann, 2007; CWRU, 2023). For this reason, it is essential that military personnel understand and employ an ethical framework to successfully overcome the complex challenges of their profession and maintain the highest standards of conduct. Thus, a morally sound military officer is more likely to follow orders, work as a team, and

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

maintain the highest standards of conduct. Studies have shown that military units with high levels of cohesion and morale perform better on the battlefield (Miron *et al*., 2024; Primoratz, 2016; Whetham, 2023).

By contrast, declining support from society, violation of human rights, damage to national reputation, loss of allies, reduced military effectiveness, prolonged instability, denial of medical assistance to adversaries, and the possibility of committing war crimes are some of the most serious consequences of using military force without deep ethical training (Blocq, 2006; Bricknell & Miron, 2021; Imbeault, 2018). As military personnel generally operate in an intricate environment, subject to stringent standards and civilian oversight, where they must make critical decisions in highly stressful circumstances, compliance with legal and ethical standards is essential to meet mission objectives and maintain public trust.

Improving individual capabilities and understanding the circumstances and complexities of efficient decision-making in high-tension settings, such as armed conflict, are tasks that face significant challenges. Indeed, as argued by Whetham *et al*. (2021), the volatile, uncertain, complex, and ambiguous (VICA) nature of military operations frequently exposes personnel to high-intensity stressors. These include the scarcity and inaccuracy of information available for courses of action, the limited time available for decision-making, the haste to use force and the ability to affect military weaponry and its possible collateral damage. These problems can greatly hamper the effectiveness of military operations.

Faced with these challenges, providing a robust education in military ethics can significantly improve the military's ability to mitigate complex situations and improve the military decision-making process (PMTD), which is defined by the U.S. military as a "methodical process that allows commanders and their personnel to apply critical and innovative thinking and doctrine to solve problems and build the framework and conditions for efficient decision-making" (Kuczynski, 2023, p. III).

Study Methodology

Reed *et al*. (2016) argue that "when comparing alternative courses of action, modern military decision makers must often consider both the military effectiveness and the ethical consequences of available alternatives" (p. 195). This is one of the advantages of implementing ESDEG's Basic Concepts in Military Ethics course. As the only joint higher education institution (army, navy, and air force) in Colombia, senior officers who are

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

responsible for the future of institutions and for tactical, operational, and strategic decision-making are accessible (ESDEG, 2024).

The Basic Concepts in Military Ethics course is part of the academic meshes of the General Staff Course (CEM) and the Military Information Course (CIM), which must be taken by officers of major grade or corvette captain (OF-3, according to the NATO classification). Taking advantage of this opportunity and after the course was implemented in the second semester of 2023, an anonymous questionnaire of 50 questions was conducted to assess the impact of students and collect information on the learning tools used.

The questionnaire followed institutional ethical procedures and obtained the informed consent of the participants. It was conducted through the SparkChart™ platform with responses rated on a 10-point Likert scale, with 10 being the highest score in terms of importance. In addition to structured questions, the survey included a free text field for additional comments. Data were collected from October 25 to November 10, 2023 and 230 responses were obtained, which correspond to 83.0% of voluntary participation with respect to the total number of students.

The group of participants of the questionnaire is made up of 204 men and 26 women, of which 223 were major or lieutenant captains (OF-3 NATO) and 7 lieutenant colonels or frigate captains (OF-4 NATO) of the army, navy and air force ($N = 230$). Of this group, 166 officers belonged to the combat corps, i.e., "those trained with the main purpose of exercising command and conduct of the combat support elements […] at all levels of the military hierarchy" (Decree Law 1790, 2000, art. 12).

Similarly, 22 officers belonged to the logistics corps, i.e.,

> Graduates of regular training school courses trained to perform technical functions, command and conduct combat service support elements of the Army, Navy, and Air Force. (art. 16)

In addition, 42 officers belonged to the administrative corps, i.e., "professionals with a university degree in accordance with the norms of higher education in force at all times, staggered in the Army, Navy and Air Force for the purpose of exercising their profession in the Military Forces" (art. 17).

29.1% of the participants (67 officers) were between 35 and 39 years old, 66.8% (155 individuals) between 40 and 44 years old, and 4.0% (8 officers) between 45 and 49 years old. The entire group had more than 14 total years of service in the military. 15.7% of participants (36 officers) had from 14-18; 82.6% (190 officers) from 19-23, and 1.7% (4 officers)

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

from 24 or over. In addition, 2.6% of participants (6 officers) had undergraduate education, 20.4% (47 officers) specialized, 75.7% (174 officers) master's, and 1.3% (3 officers) doctoral.

This means that the participating group not only had sufficient preparation and differential professional approach to know the various ethical dilemmas present in the military career, but considerable experience in the leadership and decision-making of military forces that face an armed conflict of more than sixty years against various adversaries and instability factors (Acevedo Navas, 2023; Acevedo Navas *et al.*, 2022; Villalba García *et al.*, 2022a and b).

The inductive method in the teaching of military ethics

The inductive method has application in various educational contexts, including traditional tools, such as master classes, lectures and workshops, however, its potential lies in that it encourages interaction between professors and students. By employing novel approaches, such as inquiry-based learning, problem-based learning, project-based learning, case-based learning, discovery, and just-in-time learning (Prince & Felder, 2007), the inductive method allows the educational process to evolve from specific observations to formulating general rules based on empirical evidence. In addition, it manages to prioritize the understanding of the underlying structure of arguments over mechanical memorization.

A fundamental element of the inductive method is the identification of shared human behaviors or cognitive patterns, which serve as the basis for student exploration and lead to student-centered teaching and learning. This means that a greater responsibility is imposed on the student for his own learning, compared to the traditional deductive approach (Prince & Felder, 2006). Professors guide students in formulating rules from these observations and subsequently introduce counter-factual elements to challenge and refine these rules. This iterative process cultivates critical thinking and, in particular, a deep understanding of ethical complexities.

When applied to the teaching of military ethics, the inductive method improves the development of moral competence and integrity, even though there is a natural tension between the need to obtain results and that of respecting higher ethical standards (Imbeault, 2018), through practical application and experiential learning (Todd & Tripodi, 2018; Whetham, 2011). By emphasizing the recognition of human dimensions,

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

understanding conflicting values, formulating sound judgments, effective communication, morally responsible actions, justifying determinations, and accountability for decisions (Hurtado, 2017), the inductive method offers the military a fundamental guide to confronting modern warfare.

Integrating ethical considerations into military training and operations is essential to foster a culture of ethical decision-making among military personnel. This includes understanding the legal and moral limits of military actions, as well as the implications of the loyalties health care providers may face in combat zones (Lundberg *et al*., 2019). By promoting ethical awareness and reflexivity, military ethics aim not only to prevent unethical behavior, but also to inspire a commitment to higher moral standards among service members (Lucas, 2015; Robinson *et al*., 2008).

Likewise, relating philosophical considerations (Robinson, 2007) and the particularities of the conduct of individuals in military ethical training is crucial for them to overcome the gap between perceived and actual ethical behavior, as well as for them to understand, without distinction of their spiritual orientation, the interaction between intuitive and rational decision-making, amid internal, organizational and situational factors. In this way, the inductive method in experiential learning fosters the moral reasoning and decision-making skills essential to addressing complex ethical dilemmas in military contexts.

While it is recognized that it is important for members of the military to receive an adequate education in military ethics, there is still no uniform approach to this preparation in the world, there is a lack of coherence between existing programs and there is still disagreement about the need to carry them out (Robinson, 2007; Robinson *et al*., 2008; Wertheimer, 2010). Precisely, this is the shortcoming that has sought to solve since 2015 the Center for Military Ethics of King's College London (KCME) through its contents and, especially, the course Basic Concepts in Military Ethics.

This course explores, through 18 virtual modules, the principles and applications of ethics in the military field. It covers both the fundamental theory and practical aspects of military ethics, preparing participants to face ethical challenges arising on the battlefield and in society at large. As a complement to the course contents, innovative tools have been developed, such as game cards on military ethics and a mobile application available for iOS and Android devices, which stimulates reflection and the exchange of ideas on ethical dilemmas. The questions in the letters, drawn up by ethics experts, academics, and practitioners, are based on input from legal advisors and military ethics education curricula and seek to encourage discussion of common situations that arise in military units.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

In addition, this tool guides participants to a website that offers additional information and resources for further research.

In this scenario, which encourages interaction between the teacher and the students, the inductive method has a fundamental role. Using inquiry-based learning and with the assistance of the teacher, course participants develop the activities of the modules and solve their concerns through participatory forums and representations of their own professional experiences. Likewise, using problem-based and case-based learning, professors ask questions related to the development of military operations to build consensus that transcends differences. For example, the question "Is it always acceptable to defy orders from a superior?" motivates participants to freely express their opinion and, collectively, to arrive a general assessment that allow them to understand the expected patterns of behavior in light of legal regulations (Whetham, 2018). The flexibility of this type of ethics education, which encourages students' sincere participation, not only discourages them from deviating from established norms, but also provides them with the essential skills to perform comprehensive emotional and intellectual analyzes, make decisions with discernment, and perform on the battlefield.

An innate quality of the human being is that it aspires to acquire knowledge in a conscious and rational way, so that when individuals face an ethical problem, an inherent desire to solve it and adopt a definitive point of view is generated. Once this need materializes in a tangible reality, teaching methodologies can be employed to effectively stimulate and sustain the sense of positive existence associated with an ethical commitment. In this sense, the inductive method emerges as an approach that allows to adequately meet these expectations and requirements.

The inductive method offers practical advantages in relation to classroom dynamics and student participation, as by incorporating interactive activities, case studies and group projects, professors can create dynamic and stimulate learning environments. This active learning approach improves students' motivation because they actively participate in their learning process. In addition, the inductive method allows for personalized instruction, because professors can tailor the examples and exercises to the specific needs and interests of their students.

This personalization of the learning process promotes individual growth and ensures that each student can fully understand the concepts addressed. These practical advantages of the inductive method and its ability to foster critical thinking and ethical reasoning make it a valuable tool for training future's ethical decision makers. By using the inducti-

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

ve method, professors can instill a deep understanding of military ethics and equip students with the skills needed to navigate the complex moral landscape of the modern world.

Results and discussion

A first significant result is that 93% of participants (214 officers) considered that the Basic Concepts in Military Ethics course effectively prepared them to perform their duties as officers and 95.2% (219 officers) noted that military ethics is very important for their professional life. Identical results were obtained when investigating the importance of military ethics for the other members of the forces (Table 1). This is relevant because while teaching military ethics is crucial to use cases and examples that are familiar and relevant to students' professional lives, it is common for these cases to be based on real experiences of individuals, which limits discussion with other service members. Nevertheless, any existing material that meets these characteristics should be used to the fullest, since the main objective of the examples is to sensitize students to the ethical dilemmas that arise in the military context and to promote understanding of the contributions of military ethics to the performance of the functions of men and women.

Table 1
Importance of military ethics

Value	On a personal level		For other members of the force	
	Frequency	Percentage	Frequency	Percentage
10 (Very important)	219	95.2%	219	95.2%
9	4	1.7%	4	1.7%
8	2	0.9%	2	0.9%
7	3	1.3%	3	1.3%
6	1	0.4%	1	0.4%
5	1	0.4%	1	0.4%
4	0	0.0%	0	0.0%
3	0	0.0%	0	0.0%
2	0	0.0%	0	0.0%
1 (Not important)	0	0.0%	0	0.0%
Total	230	100%	230	100%

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

In addition, 88.3% of participants (203 officers) indicated that military ethics help to improve cohesion, both within a military unit and between different military units (Table 2). Cohesion is one of the critical aspects in troop morale and unity among members of the military forces (Elron *et al*., 2000; King, 2021; Thoral, 2011), and it contributes to the transformation processes in military institutions (Ciro & Correa, 2014; Fernández Osorio, 2015; Fernández Osorio *et al.,* 2023). In this sense, a common understanding of how the military operates can contribute to improved interoperability and organizational performance.

These results allow us to infer that the teaching of military ethics through the inductive method is not only effective in the formation of critical individuals, but also promotes cohesion between military units. By exploring ethical concepts through specific examples and cases, service members are encouraged to analyze and discuss situations from diverse perspectives, which helps them develop critical thinking and understand the complexities of military ethics. In addition, this approach promotes open debate and the exchange of ideas, in such a way that it improves the military's understanding of the different perspectives that can arise in the face of the same ethical dilemma. This, in turn, fosters mutual respect and the ability to work as a team, even in the face of disagreements.

By questioning assumptions and assessing available evidence, military personnel learn to make their own sound ethical judgments. This skill is crucial on the battlefield, where quick and accurate decisions can make the difference between success and failure. Indeed, the inductive method exposes soldiers to the wide range of ethical challenges they may face in their service. Thus, by analyzing real-life scenarios and moral dilemmas, service members develop the capacity to make responsible and informed ethical decisions.

Table 2
Contribution of military ethics to improving the cohesion of military units

Value	Inside a military unit		Between various military units	
	Frequency	Percentage	Frequency	Percentage
10 (Very important)	203	88.3%	203	88.3%
9	10	4.3%	9	3.9%
8	14	6.1%	10	4.3%

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

Value	Inside a military unit		Between various military units	
	Frequency	Percentage	Frequency	Percentage
7	0	0.0%	3	1.3%
6	2	0.9%	2	0.9%
5	1	0.4%	2	0.9%
4	0	0.0%	1	0.4%
3	0	0.0%	0	0.0%
2	0	0.0%	0	0.0%
1 (Not important)	0	0.0%	0	0.0%
Total	230	100%	230	100%

This finding is also essential because the unification of criteria for discernment and action among members of military units—both foreign and domestic—contributes to the fulfillment of ERs, understood as the parameters that define the circumstances, conditions, degree, and ways in which the use of force can be applied (Bricknell & Kelly, 2023; Hosang, 2020). In this way, it facilitates the observance of ERs and the understanding of their relationship with the applicable legal regulations (Table 3).

However, incorporating real-life scenarios that correspond to the use of ER in the teaching of military ethics presents challenges for professors, since the complexity of the life stories of students does not always allow to convey clearly and concisely the concepts that are sought to teach. Each anecdote can have multiple interpretations and it is up to the instructor to guide the students towards the relevant aspects. To overcome this challenge, some professors choose to use simplified cases that are directly linked to a specific topic throughout the discussion. This approach allows a deeper exploration of the concept in question and facilitates understanding by students, but its main disadvantage is the lack of narrative continuity typical of hypothetical stories. In addition, the realism of real-life scenarios is also an advantage, as it allows students to face the complexity and unpredictability of real situations.

One solution to exploit the advantages of both approaches and achieve more effective teaching is to combine the presentation of concrete cases at the beginning of the class with a fictional story or more developed real-life cases, which stimulates a lively discussion among students.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

Table 3
Relationship between military ethics and ERs

Value	Military Ethics Facilitates Compliance with ERs		Military Ethics is compatible with ER in Colombia	
	Frequency	Percentage	Frequency	Percentage
Very important	181	78.7%	174	75.7%
9	18	7.8%	20	8.7%
8	17	7.4%	21	9.1%
7	4	1.7%	7	3.0%
6	0	0.0%	2	0.9%
5	6	2.6%	2	0.9%
4	2	0.9%	2	0.9%
3	0	0.0%	1	0.4%
2	0	0.0%	0	0.0%
Not important	2	0.9%	1	0.4%
Total	230	100%	230	100%

The finding on military ethics and ERs can be explored under the logic of the interrelationship between military ethics and effectiveness, since 86.1% of participants considered that there is a correlation between these elements (Table 4). Indeed, military ethics provide a foundation for mediating between the military's responsibilities in carrying out the mission – including new challenges, such as ensuring medical assistance (Armstrong & Hegarty, 2024), the use of lethal autonomous weapons (Kohn *et al*., 2024), and the use of artificial intelligence (Stanley Lockman, 2021) – and duties under international law (Hosang, 2020).

Table 4
Influence of military ethics
on military effectiveness and use of force

Value	Is military ethics negatively correlated with military effectiveness?		Did the military ethics course influence your perception of the use of lethal force?	
	Frequency	Percentage	Frequency	Percentage
Yes	32	13.9%	183	79.6%
No	198	86.1%	47	20.4%
Total	230	100%	230	100%

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

Table 5 presents a crucial finding: officers' understanding of the importance of behaving ethically in their decisions and in the use of force even if the opponent does not (Shereshevsky, 2022; Simmons, 2021; Sixpence & Chilunjika, 2020). This aspect is perhaps one of the most essential in the light of the application of international human rights law and international humanitarian law. Given that adversaries and instability factors in internal conflicts, such as the Colombian one, rarely adopt behaviors that respect the rights of the civilian population and its opponents (Acevedo Navas *et al.*, 2022; Arévalo Ramírez, 2022; Gangi, 2023; Ortega Guzmán & Gil Osorio, 2022; Quintero, 2018; Torres & Velandia, 2022; Villegas Arévalo, 2021), including a gender approach (Atencio, 2020; Bermúdez, 2015; Sepúlveda & Rivas, 2017), there are great challenges for members of the military to understand that their value to society and the law is intimately linked to compliance with ethical standards and regulations.

For this reason, even in spite of possible previous errors in the application of force by the Colombian military, the thinking of the officers responsible for future decision-making in military institutions corresponds to ethical behavior adjusted to the standards expected by Colombian society and to the normal development of civil-military relations (Cujabante Villamil *et al.*, 2023; Rivera Páez & Uribe Cáceres, 2022).

Table 5
Influence of military ethics on the behavior of the military

Value	Is there an obligation to behave ethically even if your opponent does not?		Does Military Ethics Depend on Cultural Specificities?	
	Frequency	Percentage	Frequency	Percentage
Yes	222	96.5%	121	52.6%
No	8	3.5%	109	47.4%
Total	230	100%	230	100%

The use e-learning as a method of "fully virtualized distance education through new electronic channels" (MINTIC, 2024) to improve the development of basic knowledge and skills has gained popularity in recent years. Although e-learning has been shown to be useful for teaching job and managerial skills (Ha & So, 2023; Ruslan *et al.*, 2021), there is still a knowledge gap about its usefulness in military education.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

While the COVID-19 pandemic brought new adaptation opportunities for military institutions to ensure the training of their personnel (Ahir *et al*., 2020; Jalili, 2022), there are still great possibilities to use new tools such as e-learning, especially on issues such as military ethics. In this regard, Table 6 presents the perception that participants have about the course and its contents. These data, together with the views of the professors, provide initiatives to continue improving the content and the pedagogical and didactic tools.

Table 6
Perception of the course Basic concepts in Military Ethics

Value	Has the military ethics course been well structured and easy to complete?		Were the course topics explained in detail and clearly?	
	Frequency	Percentage	Frequency	Percentage
Yes	209	90.9%	221	96.1%
No	21	9.1%	9	3.9%
Total	230	100%	230	100%

One of the issues to be determined is whether information technology can strengthen the capacity for moral reasoning by reinforcing important steps of the inductive method, such as detailed case analysis, the Socratic method and class participation. For this reason, the Basic Concepts in Military Ethics course develops at least three strengths of e-learning in military education.

First, it employs the design and presentation of lessons, as well as the provision of additional resources to the teacher, which can be done through technology. In this regard, Suárez and González (2021) suggest that although some didactic resources "are usually common in ethics classes […], the function of these strategies is usually nothing but to be means that allow to reach the true critical thinking based on a rational clarification based on logical analysis" (p. 187). Second, integration into the classroom through the use of digital tools to facilitate discussion and learning can be part of the inductive approach in the classroom. Finally, e-learning facilitates the improvement of inductive activities, since students can participate in more interactive and attractive activities with the help of technology.

Table 7 allows to identify the perception of participants about the structure of the military ethics course. These results are revealing, as cu-

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

rrent military ethics training programs are largely based on the development of critical reasoning skills through the study of philosophical texts, an approach that may be effective for civilian students, but whose application in the military context presents challenges. Instead of focusing on abstract theory, this course proposes a more practical approach using content and curricula developed by military ethicists. Designed specifically for the military community, these resources provide tools and concrete examples that enable students to develop ethical decision-making skills in real-life situations.

This change in approach has several advantages. First, a greater relevance, since the contents of the course allow students to relate the ethical principles with real scenarios that they could face in the development of their work. Second, more effective learning, because by using practical and relevant examples, learners can better understand ethical concepts and apply them from their own experience. Finally, the development of skills, because the training in military ethics must focus on the development of practical skills for ethical decision-making in complex situations.

Table 7
Perception on the Course Tools Basic Concepts in Military Ethics

Value	¿Did the use of the content facilitate the learning of military ethics?		¿Do you consider the platform interface design to be appropriate?	
	Frequency	Percentage	Frequency	Percentage
Yes	222	96.5%	221	96.1%
No	8	3.5%	9	3.9%
Total	230	100%	230	100%

This course proposes to remodel the training in military ethics to make it more relevant, effective and practical for students. Thus, in order to better prepare members of the military forces to face the ethical challenges that they will inevitably face in their career, content and curricula developed by specialists in military ethics are used. The results of Table 8 show that the course can partly solve these challenges, which could pose a challenge to traditional teaching methods.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

Table 8
Course review of Basic concepts in Military Ethics

Value	Overall course assessment		Assessment of the tools used in the course	
	Frequency	Percentage	Frequency	Percentage
10 (Very important)	163	70.9%	150	65.2%
9	23	10.0%	31	13.5%
8	25	10.9%	31	13.5%
7	11	4.8%	10	4.3%
6	0	0.0%	3	1.3%
5	5	2.2%	1	0.4%
4	1	0.4%	3	1.3%
3	1	0.4%	1	0.4%
2	1	0.4%	0	0.0%
1 (Not important)	0	0.0%	0	0.0%
Total	230	100%	230	100%

In military education, there are two teaching methods that dominate the landscape: lectures and group discussions. While both have their value, they have limitations and neither fully exploits the potential of the inductive method, particularly suitable for teaching ethics. Despite acknowledging the shortcomings of traditional lectures, many professors continue to use them. The reason is simple: the inductive method is sometimes unknown by a good part of professors, so its value and the potential of its tools go unnoticed or are considered unnecessary. However, its effectiveness has been demonstrated in various fields and its advantages over conventional methods make it an invaluable tool for teaching military ethics.

The inductive method, on the other hand, offers a dynamic and participatory approach that encourages active learning and critical reflection. Through the analysis of real cases and concrete examples, students not only acquire ethical knowledge, they also develop skills to identify, analyze and solve complex ethical dilemmas. Thus, the following benefits of the inductive method can be highlighted in the teaching of military ethics: first, meaningful learning promotes a deep understanding of ethical principles and their application in real situations; second, the deve-

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

lopment of critical thinking skills that strengthen the ability to analyze information, identify biases and formulate sound arguments; third, preparation for ethical decision-making provides students with the necessary tools to make sound ethical decisions in challenging situations.

Conclusions

In today's world, military forces operate in increasingly confusing scenarios, where critical decisions must be made under very stressful circumstances and under the pressure of strict legal and ethical standards. In this context, military ethics is a fundamental tool to guide soldiers' behavior and ensure that their mission is carried out in a responsible and respectful manner with human rights. On the contrary, the absence of a solid background in military ethics can lead to serious consequences and even the commission of war crimes.

A comprehensive training in military ethics allows members of the forces to develop the necessary skills and understanding to overcome the complex challenges of their profession. This training provides them with a solid framework that guides them in making responsible, thoughtful decisions based on essential principles and values. In this challenging context, the inductive method is a valuable educational tool for training in military ethics, as it allows students to develop relevant problem-solving skills in their profession, for which it integrates classroom exercises with real-life challenges. In this way, through active learning and critical reflection, students deepen their understanding of ethical principles and their application in specific situations.

Considering that one of the purposes of the inductive method is to discover and clearly expose the hidden truths that underlie a notion, it is crucial that the topic developed is fully explained. For this reason, the nature and importance of a comprehensive education in military ethics makes evident the countless possibilities of the inductive method.

Indeed, the inductive method provides an opportunity to extract universal principles, concepts, and truths from specific examples. In the realm of ethics, these particular events represent the objective truths that underpin morality. To fully grasp its message and develop a deep understanding of ethics as a whole, it is critical to set aside personal stereotypes and beliefs, actively integrating a multitude of real-life events and circumstances. Through this process, service members can gain a comprehensive

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 51-76.

understanding of the complexities of decision-making and use ethics as a guide for their actions.

While there is no absolute authority in the realm of military ethics training, the Basic Concepts in Military Ethics course, with its methodology, allows members of the forces to cultivate a deep understanding of cause-effect connections, while refining their observation and analysis skills. This experience fosters a personal development attitude that urges service members to accept challenges, gain knowledge of both achievements and setbacks, and equip themselves with the tools and strategies needed to competently address these issues.

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Artificial Intelligence Use Statement
Andrés Eduardo Fernández Osorio, Marina Miron and David Whetham, DECLARE that the elaboration of the article ***Contributions of the inductive method to the teaching of military ethics,*** had the support of Artificial Intelligence (AI) to optimize the quality and efficiency of the research. Artificial Intelligence in this article was used to: • **Comprehensive bibliographic review:** AI allowed to identify and analyze a greater number of relevant sources in less time, ensuring that the theoretical framework of the article was solid and updated. • **Improved writing and style:** AI tools were used to refine the writing, ensure stylistic coherence, and detect possible grammatical or syntax errors, which contributed to greater clarity and accuracy in the presentation of ideas. • **Translation verification:** In the case of contributions from authors whose native language is not the English language, AI was used as a support tool to verify the accuracy of the translation and maintain the original meaning of the translation. • **Adjustment to the journal's standards**: AI facilitated the adaptation of the article to the format and style requirements of Sophia Magazine, optimizing the submission and evaluation process.

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Inductive Methodologies in Education, Supported by the Integration of Technology

Metodologías inductivas en la educación, apoyadas por la integración de la tecnología

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Index h: 22

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Abstract

This paper analyzes the translation and validation of the instrument developed by Flores and Adlaon (2022) to apply the inductive method with the SAMR model in Spanish-speaking educational contexts. The justification for the topic lies in the need to adapt effective pedagogical tools to the Spanish language to facilitate their use in teaching and learning with technology. The main objectives are to translate the instrument and to carry out its semantic validation, through the judgment of experts in the educational and technological fields. The methodology included the translation of the instrument "Extent of ICT Integration in Science Based on SAMR Model" into Spanish, followed by its validation. The 11 experts evaluated the relevance and clarity of the items using a Likert scale from 0 to 5. The content validity was calculated with the Aiken V methodology, obtaining a coefficient of 0.8163, which indicates a good validity index, the Cronbach's Alpha value was 0.9682. The results showed that although most of the items were well rated, some required reformulation to improve their clarity, relevance and comprehension in the Spanish translation. The instrument proved to be adequate for evaluating the degree of integration of ICT in education, facilitating its application in Spanish-speaking contexts and promoting the adoption of inductive methodologies supported by educational technologies.

Keywords

Integration, Inductive Method, SAMR Model, Technology, Innovation, Pedagogy.

Resumen

El presente trabajo analiza la traducción y validación del instrumento desarrollado por Flores y Adlaon (2022) para aplicar el método inductivo con el modelo SAMR en contextos educativos hispanohablantes. La justificación del tema radica en la necesidad de adaptar herramientas pedagógicas efectivas al idioma español para facilitar su uso en la enseñanza-aprendizaje con tecnología. Los objetivos principales fueron traducir el instrumento y por medio del juicio de expertos en el área educativa y tecnológica, realizar su validación semántica. La metodología incluyó la traducción del instrumento Extent of ICT Integration in Science Based on SAMR Model al español, seguido de su validación. Los 11 expertos evaluaron la pertinencia y claridad de los ítems utilizando una escala Likert de 0 a 5. La validez de contenido se calculó con la metodología de la V de Aiken, obteniendo un coeficiente de 0,8163, lo que indica un índice de validez bueno, el valor alfa de Cronbach fue de 0,9682. Los resultados mostraron que, aunque la mayoría de los ítems fueron bien valorados, algunos requirieron reformulación para mejorar su claridad, pertinencia y comprensión en la traducción al idioma español. El instrumento demostró ser adecuado para evaluar el grado de integración de las TIC en la educación, facilitando su aplicación en contextos hispanohablantes y promoviendo la adopción de metodologías inductivas apoyadas por tecnologías educativas.

Palabras clave

Integración, método inductivo, modelo SAMR, tecnología, innovación, pedagogía.

Introduction

This article deals with the adaptation and validation of an evaluation instrument developed by Flores and Adlaon (2022), originally designed in English, to measure the level of integration of information and communication technologies (ICT) in scientific education, based on the SAMR model. This model is essential to guide teachers in the effective use of ICT,

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however, the absence of validated instruments in Spanish represents a challenge for its implementation in Spanish-speaking countries.

The objective of the study is to offer a translated and validated version of the instrument, capable of evaluating the integration of ICT in Spanish-speaking educational contexts. The problem lies in the lack of culturally and linguistically adapted tools to measure this aspect. It is proposed that the translated version will retain the validity and reliability of the original instrument, allowing its application with the same quality standards.

The relevance of the topic lies in the strategic role that ICTs play in 21st century education. Its integration not only complements traditional teaching methods, but deeply transforms the way knowledge is built and applied, potentially improving learning outcomes in an increasingly digitized global context.

The methodology used in this study included the translation of the original instrument and its validation by a panel of 11 experts. To analyze the content validity, the Aiken V index was used. The article is organized into five main sections: introduction, methodology, analysis of results, discussion and conclusions, followed by recommendations for future research.

The validation of instruments in the Hispanic-American context is essential to ensure that the tools used in research and educational practices are culturally and linguistically relevant. Often, the original instruments are developed in Anglo-Saxon contexts, which can lead to difficulties of interpretation and application in Spanish-speaking environments. Validating tools such as those that evaluate the integration of ICT under the SAMR model, allows educators and administrators to accurately measure the impact of technology on education. This is key to promoting active methodologies, improving learning outcomes and meeting the needs of students in an increasingly digitized world.

Ethical and pedagogical reflection on the integration of ICT in education

The use of technology in the scenarios of current society invites reflection on its integration. It is important to emphasize that technology and its use do not have defined qualities (Aguilar Gordón, 2011), i.e., they are not considered good or bad, on the contrary, their effectiveness depends on the way in which people use them and integrate them into their context. Therefore, what determines them is the ethical evaluation and the quality of judgment that is applied in order to satisfy the demands of current education.

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Whenever a technology emerges, it is presented as something new and advanced for its time. It is identified by the improvement it brings to traditional ways of doing things. However, its relevance and usefulness are temporary, hence the importance of basing its use and appropriation on pedagogical, cognitive and valuation models to understand its integration and level of appropriation that allow its constant improvement and integration especially in the educational field (Aguilar Gordón, 2011). Hence the importance of generating integration and application models that allow the development of learning based on active methodologies and deep learning, along with technological development.

The inductive method and its integration mediated by ICT in educational processes

The inductive method is defined as a teaching approach that promotes learning through observation and direct experience (Gagné, 2012), which allows students to develop knowledge from specific examples and lead them towards generalizations and principles; it fosters discovery, exploration and understanding of the world through observation and experimentation.

A fundamental component of the scientific approach is the inductive method (Palmett, 2020), since it follows stages that structure the research process until reaching the conclusions of the study. These stages include observation, data collection, verification, which allows to rigorously consolidate the findings obtained. By working from an inductive methodology, students are actively involved in the practical application of knowledge, before receiving formal explanations (Prieto *et al.*, 2014). So, there are specific situations where they must find an explanation for themselves, a solution or an answer, which allows them to investigate and discover principles, theories, laws.

This approach aims to achieve a deep, connected and applied understanding of knowledge, in addition to generating a motivation to a greater number of students to actively engage and devote more time and effort to their learning, facilitating meaningful experiences. More durable learning is promoted, in which students will value and carry out knowledge transfers to future situations.

Inductive teaching and learning, according to Prince and Felder (2013), focus on active methodologies such as case studies, inquiry, problem-based learning, case-based learning, and project-based learning. These strategies are often more effective than traditional deductive methods in achieving expected learning outcomes.

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In the digital age, ICT has modified the application of the inductive method, by facilitating access to digital educational resources and interactive tools (Gesto, 2020). Online platforms allow students to explore and collect data efficiently, as well as engage collectively to foster peer discussion and build knowledge.

The pedagogical integration of ICT

The integration of ICTs is required to support the construction of knowledge, both individually and collaboratively, since nowadays not only content is learned by listening to a class, but also with the incorporation of different digital tools to move from lower-order thinking to higher-order thinking.

Technology for decades has been linked to different didactic strategies implemented, both in virtual classrooms and in classrooms in person. They are a set of tools that enable the acquisition, production, storage, treatment, communication, records and representation of information in various formats, useful in the training processes, both for the student and the teacher. Morales Urrutia *et al*. (2021) point out that it is necessary to link the integration of technologies to the training processes through the use of pedagogical models, such as Bloom's taxonomy, considered a tool to structure and understand learning, since it allows a student to go through each of the levels until reaching the maximum understanding of the new knowledge and put into practice his creative capacity.

Methodologies for the integration of technology in learning

Cruz Meza *et al*. (2023) generate a methodology for evaluation using SAMR methods, the "pedagogical wheel", the TPACK model and the John Biggs taxonomy, to reinforce teaching strategies and promote metacognition. Its proposal supports the importance of creating methodological processes that involve the setting of objectives, the design of activities and the choice of appropriate technological tools. As a result, they note that as taxonomic levels are promoted, the integration of technology reinforces higher-order thinking in the student.

Within this context, the integration of pedagogical approaches such as the inductive method, combined with technological tools and innovative models such as Allan Carrington's pedagogical wheel (2016), has shown a potential to enrich the educational experience, focusing on pedagogy instead of technological applications. This graphical tool faci-

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 103-129.

litates the integration of technology with the teaching-learning process and its design consists of several axes:

- Central axis representing the six cognitive levels of Bloom's taxonomy.
- Axis with four degrees of technological integration according to the SAMR model.
- Outer axis containing examples of technological tools and applications that can be used at each cognitive and technological integration level.

Each section of the wheel interconnects with the other sections, confirming that learning is not linear, but is in a process of evolution.

The foundation of Carrington's pedagogical wheel (2016), integrates two theoretical frameworks (Bloom taxonomy and SAMR model) in a visual representation that simplifies the combination of tools and technological strategies appropriate for each level of cognitive ability and technological integration. For Bloom's taxonomy (Campos, 2021), ascending from the basic to the most complex level is understood as inductive knowledge and is the starting point for incorporating technology into learning procedures.

The SAMR model, developed by Puentedura in 2014, consists of four levels of application, which are associated with Bloom's taxonomy: remember, understand, apply, associated with the levels of substitution and increase of the SAMR model, while the levels of modification and redefinition are associated with the levels of analysis, evaluation and creation of Bloom. The model is the guide for choosing activities to be used within a learning process that includes technology. The wheel of pedagogy is the element that helps to choose digital tools that can be used to develop the activities and take the student through each of the taxonomic levels to achieve metacognitive learning.

Therefore, it helps educators to select applications and technological resources that can be used to support different levels of cognitive skills ranging from memory and understanding, to creation and evaluation; it organizes technological applications around educational actions that support each level of Bloom's taxonomy (Carrington, 2016), fostering a clear and accessible framework for implementing technologies in the classroom in an effective and coherent way.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 103-129.

The integration of the inductive method, the pedagogical wheel and ICT

This integration can transform the learning experience by providing students with opportunities to actively explore, experiment and build knowledge. The main contributions of this combination are highlighted below, accompanied by critical analyzes of its impact:

- *Observation and active exploration:* with the support of the pedagogical wheel, students can access applications and tools that facilitate the observation of phenomena and the direct collection of data (McKnight *et al*., 2016). For example, augmented reality applications allow to explore scientific concepts in a tangible and interactive way. This not only simplifies the understanding of complex topics, but also encourages active and autonomous learning, pillars of the inductive approach. The use of tools such as augmented reality generates a significant impact by transforming abstract concepts into concrete experiences, which strengthens the interest and motivation of students.
- *Guided discovery and constructivist learning:* the inductive method stimulates constructivist learning, where students build their knowledge through experience and reflection. The pedagogical wheel offers technological resources that enable guided discovery, such as virtual experiments and interactive simulations, that help students develop a deep and meaningful understanding of concepts (Johnson *et al*., 2016). This stage fosters critical thinking and problem-solving ability by allowing students to become protagonists in their own learning.
- *Reflection and generalization:* the technological tools integrated in the pedagogical wheel allow students to reflect on their experiences and generalize the acquired knowledge. Applications such as blogs and digital portfolios make it easier for them to document and analyze their learning, promoting the transition from specific experiences to general principles (Carrington, 2016). Reflection is a crucial component in meaningful learning, as it allows students to consolidate what they have learned and connect it to broader contexts.
- *Creation and evaluation:* In the final phase of inductive learning, students can employ technological tools to design projects and evaluate their achievements. The pedagogical wheel includes applications for the creation of videos, presentations and other materials,

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 103-129.

which allows to synthesize and share their discoveries in a creative and collaborative way (Carrington, 2016). This not only reinforces learning, but also drives the identification of achievements and areas for improvement in the training process. The creation allows students to develop key competencies such as communication, creativity and teamwork. In addition, the evaluation process encourages self-reflection and continuous improvement.

The integration of the inductive method, the pedagogical wheel and ICTs promotes dynamic, reflective and oriented learning in the development of essential competences for 21st century education. However, its success requires an intentional pedagogical design, appropriate teacher training and a balanced approach that considers both the opportunities and the challenges of these innovations.

The union of the above elements encourages active and autonomous learning, allowing students to discover and build knowledge from concrete and real experiences. By incorporating technology, opportunities to perform simulations, access global resources, and collaborate in virtual learning environments are diversified, enriching the induction process. This combination not only improves understanding and retention of knowledge, it also develops critical skills for the 21st century such as problem solving, critical thinking, and the ability to adapt to information and communication technologies.

Benefits of the educational wheel

The application of the inductive method, supported by the pedagogical wheel and technology, offers a variety of contributions in the educational field. These are reflected in the improvement of the learning experience and the integral development of the students. The main benefits and critical analysis are highlighted below:

- *Fostering curiosity and creativity:* the inductive approach stimulates students' innate creativity by offering them opportunities to explore and discover concepts for themselves. This is enhanced by technological tools, which provide new forms of interaction and experimentation, such as virtual simulations, augmented reality applications and digital creation spaces (Roblyer & Doering, 2013). Curiosity and creativity are fundamental to deep learning, as they motivate students to actively participate in the educational process. Success in this regard, however, de-

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 103-129.

pends on the right selection of technological tools and a pedagogical design that fosters a balance between creative freedom and clear educational goals.

- *21st century skills development:* the combination of inductive method, pedagogical wheel and ICT facilitates the development of key competences such as critical thinking, problem solving and digital literacy. These skills are essential in the contemporary world, where students must adapt to changing environments and solve problems in innovative ways (Johnson *et al.*, 2016). Such competencies not only prepare students to face job challenges, but also enable them to become responsible and proactive citizens. However, 21st century skills development requires an intentional integration of activities that promote the analysis, collaboration and reflective use of technology, avoiding the superficial or exclusively technical use of tools.
- *Personalization of learning:* technology allows learning to be personalized in an inductive environment, offering students the possibility to advance at their own pace and focus on their specific interests and needs. This is especially relevant in a student-centered approach, where autonomy and meaningful learning are priorities (McKnight *et al.*, 2016). Personalization of learning has the potential to increase students' motivation and commitment by connecting educational content with their personal interests. This poses logistical and pedagogical challenges, such as the need for an adequate technological infrastructure and the ability of the teacher to design differentiated strategies that maximize the potential of each student without generating inequalities.

The integration of the inductive method, the pedagogical wheel and technology offers a powerful framework for transforming education. However, its successful implementation depends on careful pedagogical planning, teacher training and strategic selection of technological tools that enhance learning objectives. The inductive method, in combination with Allan Carrington's pedagogical wheel and the use of ICT, represents an innovative approach to teaching-learning in the 21st century, as it allows facing the challenges and opportunities of an increasingly complex and digital world.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 103-129.

Research on the educational wheel and the SAMR model

There are different investigations that address the use of the pedagogical wheel, among which Cepeda Moya and Argudo Serrano (2022), who recover the perceptions of both teachers and Ecuadorian students about the SAMR model through an interview, where results emphasize the beneficial uses of technology for meaningful learning.

The use of the pedagogical wheel is also linked to the use of artificial intelligence (AI) tools in the research of Jiménez García *et al.* (2024), who carried out a systematic mapping of the literature and highlight the incorporation of AI gradually, in addition to including a metacognitive level of reflection where the importance of ethics and academic integrity is highlighted.

Flores and Adlaon (2022), carry out a study that addresses the integration of teachers' ICT from the SAMR model of Puentedura (2014). Flores and Adlaon (2022) produce a questionnaire validated by experts and subjected to statistical tests. The study concludes that the incorporation of ICT improves student learning, however, the instrument is in English. Therefore, the objective of this article is to translate and validate the instrument Degree of Integration of ICT according to the SAMR model, through judges, to be used by teachers from Latin America and from the results obtained, generate practices oriented to continuous improvement.

Materials and methods

In this research article, a quantitative methodology was adopted, focused on the validation of the evaluation instrument of the SAMR model adapted to Spanish. The research is framed in a non-experimental design, using as main techniques the translation and validation of the instrument by applying the Aiken V to measure the validity of content. The data collection was carried out with the collaboration of 11 experts in the field of education and ICT, who evaluated the clarity and relevance of each item.

From a post-positivist epistemic position, this research ensures the objectivity and reliability of the results, proposing that reality can be known through rigorous methods that allow corroborating or falsifying hypotheses. The study is based on the idea that educational phenomena, in this case, the integration of ICT, can be measured and understood objectively, which allows offering adequate and validated tools for Spanish-speaking educational contexts. Thus, an empirical approach is combined

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 103-129.

with the need to culturally contextualize the instrument to ensure its applicability and relevance.

The consistency of an instrument in a research process involves judging components that have to do with the validity of the content, criterion and construct, each of them alludes to a different aspect and the use of one or the other will depend on the type of evidence that is intended to be used (Robles Pastor, 2018). In this sense, content validation, according to Escobar Pérez and Cuervo Martínez (2008), applies to different situations, especially when it comes to the design of a test or the assessment of an instrument created for subjects from different regions adapted through semantic equivalence or translation.

The conceptual essence of the term "content validity" involves assessing the extent to which the items of an instrument are relevant and represent the purpose of its construction. When these have been adapted or translated into a different language, it is very common for the interpretation or approach in a new language to generate interpretative or cultural gaps, which require the judgment of experts. They are the ones who, due to the experience in the area, determine which items should be eliminated, modified, reconstructed or even add new terms or concepts that are considered relevant to replace the idiomatic expressions and that the instrument gains more relevance and representativeness (Escobar Pérez & Cuervo Martínez, 2008).

Previous studies (Guerrero Fernández *et al*., 2022) report the creation and validation of an instrument to measure the different dimensions and items with the aim of analyzing both clarity and relevance. The results show how the process of evaluation by judges allowed to evaluate an instrument to detect the degree of environmental literacy of future teachers of early childhood and primary education through the Aiken V.

In addition, Alemán Saravia *et al*. (2023, p. 463) identify the imperative need for assessment tools within the Latin American population to measure the degree of integration of technology, pedagogy and content as base elements for teaching performance, so they developed a translation, cultural adaptation and validation of the TPACK-21 questionnaire. The results allowed validating the instrument to be applied reliably to primary and secondary teachers in Peru.

For the present research, the validation was carried out for the Spanish translation of the Extent of ICT Integration in Science Based on SAMR Model, which was divided into the four original sections that allow to analyze the level of ICT integration: substitution, argumentation, modification and redefinition (table 1). In order to improve reliability, it

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 103-129.

was decided to eliminate the response option with a value of 0, taking it as the minimum value or one that reflected total disagreement with the proposal presented and was replaced for analysis by the value of 1. However, in the presentation to the judges, the scale was developed with a range of responses from 0 to 5 to validate the basic criteria of: relevance (correspondence of the content of the item and the dimension for which it is to be used) and clarity (degree to which the item is written clearly and precisely, facilitating understanding for respondents).

Table 1
Dimensions and descriptors of the instrument

Dimension	Item	Pedagogical wheel	SAMR. Model Application Criteria
Replacement	1–10	Remember, learn, apply technology	Replace without functional change
Increase	1–10	Remember, learn, apply technology	Replace with functional enhancement
Modification	1–10	Analyze, evaluate, create	Significant task redesign
Redefinition	1–10	Analyze, evaluate, create	New tasks that were previously inconceivable

Formation of the expert group to initiate validation

The group of judges consisted of 11 researchers from various universities. It was determined that they had the degree of doctor preferably in the lines of education and ICT, as well as the performance within the teaching at the university level. Likewise, it was determined to consider those who work with the use of technology within the classroom due to their educational profile.

The Spanish version of the instrument was sent to the judges and they were asked to make a judgment by means of a Likert scale where the value of 0 corresponded to the minimum relevance and/or clarity in the item, and 5 corresponded to the maximum value of these criteria.

Subsequently, the conformation of the database of the results obtained was made. For its validation, the "content validity coefficient" was obtained through the methodology of Hernández Nieto (2002), with a result of 0.8163. This places it as a good instrument within the evaluative scale. Those items that scored less than 0.80 and matched the suggested

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 103-129.

changes were modified as observed by the judges. Otherwise, the modification was made to make its translation clear and relevant. The changes are shown in Table 2, within the qualitative assessment of the validity of the instrument.

For the statistical valuation of the instrument, the responses of the 11 experts were collected with the valuation of the instrument of each of the items. The analysis was carried out using a database developed in Excel and Aiken's formula V was applied. In general, the final score of the four dimensions is observed in Table 3.

Analysis and results

Table 2 shows the results of three of the dimensions that make up the instrument. In the *substitution* dimension, item 6 has a score of 0.752, which is why it is reformulated to integrate the comments and observations issued by the judges. However, reagents 4, 5 and 9 meet the construct value greater than 0.75, these are modified according to the observations of the experts. For the *argumentation* category of the 5 redesigned items, the 9 get a score of 0.743; i.e., below the minimum construct validity level, so it is adapted for greater understanding. For the *modification* dimension none of the items was below the value; however, items 3, 4, 7 and 8 are reformulated to address the points in the evaluation process and achieve a better interpretation in their translation. In the *redefinition* dimension only item 9 was below the construct value, with a score of 0.685, which implied its restructuring.

Table 2
Results of construct value

Dimension	Item No	Construct Value
Replacement	6	0.752
Argument	9	0.743
Redefinition	9	0.685

Qualitative validity assessment

The reformulated items of the replacement dimension were 4, 5, 6 and 9; once evaluated by the expert these are modified for a better unders-

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 103-129.

tanding. In the case of item 4 used to evaluate the creation of mental maps using Microsoft Word, it is suggested to add specialized apps such as: Office, Libre office, Google Slides, Smart Office, Adobe Reader, Polarice office, among others. For submitting projects in the case of item 5, it was suggested that it should not be limited to email or Facebook, but that these digital platforms should be integrated as an element that improves communication between participants.

Item 6 measures the tabulation of data using electronic counting sheets when the experiment is performed, and it is reformulated for better interpretation, remaining as follows: during the performance of experiments the data are recorded in electronic spreadsheets, allowing an organized handling of information and a more accurate analysis of it. Finally, for this dimension, item 9, which measures the use of digital images to make a virtual visit, is reformulated considering the importance of pointing to copyright or author data.

In the dimension of argumentation, items 4, 7, 8, 9 and 10 are suitable for the use of digital tools that integrate animations and locutions (item 4); its reformulation focuses on narrative for better understanding. Item 7 in its translated version is not clear, so it is drafted in a more detailed way. Item 8 measures the use during the class of videos of other speakers related to the lesson. The results obtained are modified to specifically indicate the incorporation of videos made by experts and external speakers. The integration of video clips for a virtual visit (item 9) is redefined by adding augmented reality applications to perform virtual visits and strengthen knowledge. Finally, item 10 is reformulated as a result of the evaluation, adding items such as the Google Sheets spreadsheet.

For the *modification* dimension, the items reformulated according to the results obtained were 3, 4, 7 and 8. In this category, the judges considered the importance of digital tools as support for the creation of collaborative and interactive processes. In this sense, elements such as the e-portfolio are integrated to document and generate evidence of work using web platforms such as: Google Sites blogs, OneDrive, Dropbox in item 3.

Item 4 is modified since the judges valued the importance of improving its semantic writing, remaining as follows: synchronous discussions are implemented through chats and/or group blogs to create conceptual or mental maps in a team. The translated version was not clear about collaborative work in a synchronous way and the potential that this type of activities can generate in the class.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 103-129.

As for the translation of item 7 that points out: the annotation of the e-books, e-handouts or e-notes of class (Notes App, Google Doc or Microsoft Word), it is done in a collaborative way. Semantic elements are added after the assessment, leaving a more descriptive version that emphasizes the registration of the class work in a collaborative way. Finally, the translated wording of item 8, contrasted with the version modified at the suggestion of the experts, focuses on the use of more common words in the Latin American continent, for example, the change from "student" to "student" is observed.

The dimension of redefinition had to be modified in items 1, 7 and 9. The first two, despite obtaining a score greater than 0.75 in the construct value, integrate in its translated version the aspects suggested by the judges for a better understanding in its wording, for example, the active collaboration in Google Forms, Kahoot, Mentimeter, etc., is implemented in the realization of questionnaires that serve as review material (item 1), is modified by: *it implements* the active collaboration *through the use of interactive applications such as* Google Forms, Kahoot, Mentimenter among others, *to generate* questionnaires that serve as review material.

Regarding items 7 and 9, the semantic changes seek to integrate at the suggestion of experts, aspects about the use of collaborative work and virtual reality to enrich learning experiences. For example, item 9 is modified as follows: virtual tours are implemented through the use of virtual reality to generate immersive learning experiences.

Other changes suggested by the judges related to the incorporation of free *software*, the integration of AI, as well as the description of the acronyms LMS (*learning management system*) and MS (Microsoft). On the other hand, it was requested to translate the word *online* as well as to replace Microsoft Word with "word processor" in those items that mention the use of the program for the conduction of some activity related to the elaboration of text documents. It was suggested to make clarifications about the concept of "virtual visit", so we choose to integrate "immersive spaces" or "virtual reality" to focus attention on the generation of educational experiences where technology can generate experiential learning.

Statistical validity assessment

Cronbach's alpha value was 0.9682, which reaffirms the validity of the Extent of ICT Integration in Science Based on SMAR Model by Flores and Adlaon (2022), in its Spanish translation. Aiken's V was applied to each of

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 103-129.

the dimensions, which quantifies the relevance of the items in relation to the validity of content from the evaluations of the judges (Aiken, 1980).

Table 3
Cronbach alpha value of the instrument

K	80
Item Variance	0.08
Si2	92.00
St2	2099.54
α	0.9682843737

The questionnaire with 80 reagents has a low average variance (0.08), suggesting that the responses are homogeneous. The total test variance is 2099.54 and the average variance is 92.00. The Cronbach alpha value of 0.968 indicates excellent internal consistency, which means that the reagents are highly reliable and consistently measure the construct to be evaluated. In summary, these data suggest that the questionnaire is very reliable and suitable for research or evaluation.

Table 4
Cronbach alpha value of "relevance"

α (alpha)	0.8958762405
K (number of items)	40
Vi (variance per item)	45.30578512
Vt (total item sum variance)	358.09

The questionnaire with 40 reagents presents a relatively high average variance (45.31), indicating that there is considerable variability in individual responses. The total variance of the test is 358.09, suggesting that the total scores obtained by the individuals in the test also show good dispersion. The Cronbach alpha value of 0.896 indicates a high internal consistency. In summary, these data suggest that the questionnaire is reliable and suitable for research or evaluation as results are consistent and responses vary significantly among participants, providing a good basis for interpretation.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 103-129.

Table 5
Cronbach alpha value of "clarity"

α (alpha)	0.964993639
K (number of items)	40
Vi (variance per item)	46.52892562
Vt (total item sum variance)	786.8760331

The questionnaire with 40 reagents presents an average variance of 46.53, indicating considerable variability in individual responses. The total variance of the test is 786.88, suggesting that the total scores obtained by the individuals show a wide dispersion, reflecting a good discrimination between different levels of skill or knowledge among the participants.

The Cronbach alpha value of 0.965 indicates excellent internal consistency, meaning that the items are very well correlated and that the test consistently measures the construct to be evaluated. In summary, these data suggest that the questionnaire is highly reliable and suitable for research or evaluation, as it provides consistent and valid results with good discrimination between participants.

Table 6
Aiken V values of the dimension "substitution" by reagent

	Item	Criterion	Average	D. e. p.	V of Aiken	Bottom Lim	Top Lim
Replacement	Item 5	Clarity	4.5	1,157	0.041	0.012	0.159
		Relevance	4.3	1,213	0.025	0.005	0.132
	Item 6	Clarity	3.9	1,443	–0.008	0.001	0.070
		Relevance	4.3	1,355	0.025	0.005	0.132

For the substitution dimension in reagent 6, an Aiken value of –0.008 was obtained for the category of clarity, which corresponds to the construct validity and the modification suggested by the judges. In this same dimension, reagent 5 obtains a value of 0.025, coinciding with its restructuring according to internal validity.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 103-129.

Table 7
Aiken V values of the dimension "argumentation" by reagent

	Item	Criterion	Average	D. e. p.	V of Aiken	Inferior Lim	Superior Lim
Argument	Item 14	Clarity	4.5	1,157	0.050	0.016	0.171
		Relevance	4.2	1,527	0.017	0.003	0.118
	Item 17	Clarity	4.4	1,226	0.033	0.008	0.146
		Relevance	4.1	1,505	0.008	0.001	0.103
	Item 18	Clarity	4.5	1,157	0.050	0.016	0.171
		Relevance	4.2	1,527	0.017	0.003	0.118
	Item 19	Clarity	4.4	1,651	0.033	0.008	0.146
		Relevance	4.0	1,651	0,000	0,000	0.088

For the dimension of argumentation, items 14, 17, 18 and 19 according to the above table have a coincidence with construct validity and have been modified in the wording for a better understanding in its Spanish translation. The values obtained in the validity of the construct agree with Aiken's score and have been modified for its better understanding.

Table 8
Aiken V values of the dimension "modification" by reagent

	Item	Criterion	Average	D. e. p.	V of Aiken	Inferior Lim	Superior Lim
Modification	Item 27	Clarity	4.2	1,266	0.017	0.003	0.118
		Relevance	4.5	0.782	0.050	0.016	0.171
	Item 28	Clarity	4.5	1,157	0.050	0.016	0.171
		Relevance	4.2	1,527	0.017	0.003	0.118

For this dimension, reagents 27 and 28 obtain a coincidence in Aiken's assessment and in relation to construct validity according to Hernández Nieto (2002), so they are modified in their wording. Although reagents 23 and 24 are not at a high level of coincidence, these were modified at the suggestion of the judges.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 103-129.

Table 9 Aiken V
values of the dimension "redefinition" by reagent

	Item	Criterion	Average	D. e. p.	V of Aiken	Inferior Lim	Superior Lim
Redefinition	Item 31	Clarity	4.5	0.988	0.041	0.012	0.159
		Relevance	4.5	1,157	0.041	0.012	0.159
	Item 37	Clarity	3.7	1,150	–0.025	NULL	NULL
		Relevance	3.9	1,781	–0.008	0.001	0.070
	Item 38	Clarity	2.8	1.992	–0.107	NULL	NULL
		Relevance	3.2	1.992	–0.074	NULL	NULL
	Item 39	Clarity	4.6	0.881	0.058	0.020	0.184
		Relevance	4.7	0.862	0.066	0.024	0.196

The redefinition dimension obtained in items 31, 37, 38 and 39 a score of 0.041, –0.025, –0.107 and –0.074, which coincides with the validity of the construct and suggestions for modification of the judges, so that their restructuring is carried out; they are modified and adapted for a better understanding in their translation into Spanish.

The instrument in its Spanish version

The objective of this work is to obtain a translated and validated version of the instrument created to assess the degree of integration of ICT in science according to the SAMR model (Flores & Adlaon, 2022). It is considered extremely necessary to present the translated and validated version of the instrument so that the population of researchers and university professors can apply it in Spanish-speaking research that aims to measure the level of use and appropriation of technology in the educational field.

Each of the dimensions modified according to the statistical and qualitative results obtained are presented below. The measurement scale for each of the parameters is from 1 to 4, where 1 expresses the option of "totally disagree", option 2 "disagree", the value of 3 describes the option of "agree" and 4 corresponds to "totally agree".

Replacement

1. Forms from Google, Kahoot, Mentimeter and other tools are used in formative and summative assessments.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 103-129.

2. Images or mock-ups are used to make a visual presentation of the lessons.
3. Some word processor is used when preparing electronic portfolios
4. Conceptual or mental maps of the lessons are created using diverse software that replaces specialized apps such as: Office, Libreoffice, Google Slides, Smart Office, Adobe Reader, Polarice office, among others.
5. Projects are sent through digital platforms, such as email or Facebook Messenger. This replaces the physical delivery of documents allowing communication to be more efficient and faster.
6. During the conduction of experiments the data are recorded in electronic spreadsheets, allowing an organized handling of the information and a more precise analysis of it, thus replacing manual recording of information.
7. Evident-Notes (Notes App, Google Doc or word processors) are used for note-taking.
8. Pre-recorded lessons are used during the class.
9. Digital images are used without copyright or mentioning the author to know a place, space or community virtually.
10 Record sheets are used to record data collected in research studies.

Argument

1. Multimedia is integrated into Google Forms, Kahoot, Mentimeter, etc., to improve students' understanding of how to conduct formative and summative assessments.
2. The lesson features video clips to explain and support the visual presentation.
3. Use of Microsoft Word.
4. Conceptual or mental maps are created using digital tools that allow the inclusion of animations to make the lessons more dynamic and interactive.
5. Projects are uploaded and compiled directly into an online folder for centralized feedback and enhancements.
6. MS Excel or spreadsheet is used to present the data when the experiment is performed.
7. Electronic notes are enriched by integrating multimedia elements such as images, videos and other digital elements using applications such as: Notes App, Google Doc, or word processors to complement textual information.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 103-129.

8. The class incorporates videos from experts and external speakers related to the topic to complement the content of the lesson.
9. Video clips or augmented reality applications are used to conduct virtual tours and reinforce knowledge.
10. Microsoft Excel or some other spreadsheet application such as Google Sheets is used to generate charts and present data from a research study.

Modification

1. Forms from Google, Kahoot, Mentimeter, etc., always show scores and comments after formative and summative evaluations.
2. Augmented reality or any live 3D enhancements are applied to improve the visuals of the lessons.
3. E-portfolios are created to document and generate evidence of work using web platforms such as: Google Sites blogs, OneDrive, Dropbox.
4. Synchronous discussions are implemented through chats and/or group blogs to create conceptual or mental maps in a team.
5. Projects are submitted using Google Classroom or another LMS for automated tracking.
6. The experiment class data is published on an online platform to view graphs and tables in real time.
7. The class work is recorded in a collaborative way using applications such as: Notes App, Google Doc or word processors, to generate e-books, e-handouts or e-notes.
8. Students are encouraged to be part of online courses related to the lesson to reinforce their learning.
9. Google Earth is used for a virtual tour.
10. The delivery of hyperlinked surveys to community members and the local population is used to collect data in a research study.

Redefinition

1. Active collaboration is implemented through interactive applications such as Google Forms, Kahoot, Mentimenter among others, to generate questionnaires that serve as review material.
2. Virtual reality is used for the immersive content of lessons.
3. Evidence portfolios are reviewed or evaluated by students on Google sites or on any blog site in the comments section.

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 103-129.

4. The class collaboratively contributed to the concept or mind map for the entire lesson through an active online platform.
5. Projects are submitted via Google Classroom or other LMS and are reviewed or evaluated by students in the comments section.
6. The result of the experimentation is shared on-screen in the class for discussion.
7. The class actively collaborates in the generation of class notes and scores them on an online platform.
8. Students are encouraged to participate and comment in the contributions section of the massive open online courses (EdX, Coursera, Khan Academy, Canva).
9. Virtual tours are implemented through virtual reality to generate immersive learning experiences.
10. To collect data in a research study, online surveys are published to target a global audience.

Discussion

The validation of the instrument to evaluate the integration of ICT in scientific education, adapted to the Spanish-speaking context, has revealed significant findings that should be discussed in depth. First, the methodology used, which included the translation and validation of the instrument through an expert panel has proven effective in ensuring clarity and relevance of the reagents. The application of Aiken's V has allowed establishing the validity of the instrument's content, which is crucial for its use in specific educational contexts.

It is important to identify previous studies that have been carried out on the translation and adaptation of instruments oriented to the use of technologies. German Saravia *et al*. (2023) carried out the translation, adaptation and validation of Valtonen's "Questionnaire on technological, pedagogical and content knowledge for 21st century skills" (TPACK-21). The experience of Lobos *et al*. (2022) is also recovered, since they carried out the adaptation and validation of two questionnaires on the implementation of technology in university teaching; from the validation, the authors identify four factors different from the original proposal and make the appropriate adjustments. Likewise, Cabero Almenara and Palacios Rodríguez (2020) carry out the translation and adaptation of the DigCompuEdu Check In questionnaire, in order to improve the level of

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 103-129.

digital competence of teachers from the implementation of training and personalized plans.

The results obtained indicate that the integration of ICT in education is not only necessary, but can also be measured effectively using culturally adapted tools. This is especially relevant in a context where education is constantly evolving due to the rapid adoption of digital technologies. Discussion of the effectiveness of ICT in learning aligns with previous studies, suggesting that technology can transform the way knowledge is built and applied.

In this sense, the implementation of pedagogical models such as *e-learning, b-learning* and *mobile learning,* which have been favored by the integration of ICT, has been a focal point in the discussion. These models not only promote more active and collaborative learning, but also encourage students' participation in building their own knowledge, as well as the ability to collaborate online and generate content, such as mind maps and class notes, highlighting the importance of digital platforms in the educational process.

Finally, this study opens the door to future research that could explore the application of the instrument in different educational contexts and its impact on learning outcomes. Validation of culturally adapted assessment tools is essential to ensure that the specific needs of educators and students in the Spanish-speaking environment are addressed, thereby promoting more inclusive and effective education.

Conclusions

The use of ICT offers the possibility of incorporating new tools, resources, media and formats, which allow the application of didactic strategies in the construction of knowledge. The application of pedagogical models such as *e-learning, b-learning* or *mobile learning* is considered an innovation of modern learning, which encourages teachers to organize, design and create materials, becoming a mediator and connector of various forms of didactic accompaniment (Cobos *et al*., 2020).

This study has managed to translate and validate an instrument designed to evaluate the integration of ICT in scientific education, adapting it to the Spanish-speaking context. Through the collaboration of a panel of 11 experts, it has been confirmed that the Spanish version of the instrument maintains its validity and reliability. The results of the analysis of Aiken's V and Cronbach's alpha have shown a high agree-

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 103-129.

ment between the evaluators in terms of the clarity and relevance of the reagents, suggesting that the instrument is suitable for its application in educational practice.

Validation of this tool is crucial as it provides educators and administrators with an effective tool to measure the use and ownership of ICT in higher education. This improves pedagogical practices and encourages research in a field that is increasingly relevant in a digitized world. The adaptation and validation of assessment tools such as the one presented in this study are essential to ensure that educational methodologies are culturally relevant and linguistically appropriate, which not only benefits researchers and professors in Spanish-speaking countries but promotes a more inclusive and effective approach to the integration of ICT in education.

Future research could explore the application of the instrument in different contexts and educational levels and its impact on learning, as well as the need for continuous training for teachers in the use of ICT, ensuring that technological integration is carried out effectively and meaningfully.

These recommendations aim to strengthen research and educational practice, promoting a more effective and contextualized use of ICT in scientific teaching. It should not be forgotten that the teaching role in a training process involves the design of instruction and the development of content using technology. Valverde and Balladares (2017) point out that the role of students has to do with the interaction and communication that is given through ICT and their integration with the in-person or virtual educational environments, creating links, processes, and essential collaborations to build learning communities.

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Induction and Analogy in Applied Ethics in Socio-Educational Projects

Inducción y analogía en las éticas aplicadas en proyectos socioeducativos

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Index h: 15

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Index h: 1

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Index h: 2

Abstract

The objective is to highlight the advantages of articulating induction and analogy with applied ethics in socio-educational projects. The review of articles shows that ethics underpinned by deductive logic predominate in social projects, but some studies reveal dialogic and critical applied ethics structured with induction and analogy. Theoretical positions on the status of applied ethics are examined, confirming that induction and analogy are present both in the casuistry that culminates in the construction of maxims or prudential criteria, and in procedures that require the participation of those involved in each concrete case, and in the circle of critical hermeneutics with its dialectics. Using an analytical-synthetic procedure, 12 socio-educational projects carried out in a non-formal modality are examined. As a result, four combinations are distinguished: 1) prescriptive ethics and deductive logic; 2) ethics of recognition and alternate logics; 3) dialogic ethics and logic of discovery; and 4) prudential ethics of critical hermeneutics and dialectical logic. It is concluded that, by including induction and analogy in the ethics applied in socio-educational projects, a contribution is made to the improvement of learning and the production of behavioral patterns and moral convictions in accordance with the respective context.

Keywords

Social Education, Ethics, Logic, Morals, Induction, Social Learning.

Resumen

El presente trabajo busca las ventajas de articular la inducción y la analogía con las éticas aplicadas en proyectos socioeducativos. La revisión de artículos muestra que en los proyectos sociales predominan las éticas principialistas, a las que subyace una lógica deductiva, pero algunos estudios revelan éticas aplicadas de corte dialógico y crítico estructuradas con la inducción y la analogía. Se examinan posiciones teóricas sobre el estatuto de las éticas aplicadas, confirmando que la inducción y la analogía están presentes, tanto en la casuística que culmina en la construcción de máximas o criterios prudenciales como en procedimientos que exigen la participación de los involucrados en cada caso concreto, y en el círculo de la hermenéutica crítica con sus dialécticas. Mediante un procedimiento analítico-sintético se examinan 12 proyectos socioeducativos realizados en modalidad no formal. Como resultado, se distinguen cuatro combinaciones: 1) ética prescriptiva y lógica deductiva, 2) ética del reconocimiento y lógicas alternadas, 3) ética dialógica y lógica del descubrimiento y 4) ética prudencial de la hermenéutica crítica y lógica dialéctica. Se concluye que, al incluir la inducción y la analogía en las éticas aplicadas en proyectos socioeducativos, se contribuye a la mejora de los aprendizajes y a la producción de pautas de comportamiento y convicciones morales acordes con el contexto respectivo.

Palabras clave

Educación social, ética, lógica, moral, inducción, aprendizaje social.

Introduction

The topic of this work is the logic that underlies the applied ethics in socio-educational projects. This is a relevant theme because socio-educational projects usually target vulnerable populations with the intention of contributing to the solution of some pressing problem (access to drinking water, food sufficiency, physical and mental health, among others).

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The objective is to show the advantages that inductive and analog logic bring in the structuring of the ethics that are applied in this type of projects. It is based on an assumption that has two components:

- Every project and intervention in the social field has an ethical dimension that lies in the interactions, the purposes and values that it involves, as well as in the principles, guidelines and procedures that are followed to make decisions when faced with problematic ethical situations. This dimension is known as "applied ethics."
- The set of elements that constitute an applied ethics underlies one or more logical procedures that give it structure (deduction, induction, analogy or a combination of them).

The problem referred to in this article alludes to the fact that educational work in any of its modalities and functions always carries an ethical dimension with its corresponding logics, not only because in educational processes values and forms of being moral constitute purposes, but also because ethics is present in the interactions that shape those processes. The ethical dimension in education has been widely studied in terms of professional ethics and classroom interactions of different types and levels, but research has been scarce when it comes to socio-educational projects that are usually carried out in a non-formal modality. Hence, the idea is to identify which are the prevailing logics in these projects, which applied ethics are combined and what effects this combination has on learning and the shaping of moral dispositions.

When it comes to applied ethics, there is a tendency to argue that principled ethics, which underlie deductive logic, are the best way to face dilemmas and make decisions. Faced with this principled tendency, the idea defended in this work is that, by including induction and analogy in socio-educational projects, it contributes to the improvement of learning and the production of patterns of behavior and moral convictions in accordance with the respective context.

The methodology applied is analytical and qualitative. It examines in 12 cases how applied ethics (interactions, values, purposes) is articulated with the logic(s) that structure it, paying special attention to the effects of interactions, educational purposes and the construction of guidelines and criteria of moral judgment. As a result of this test, four types or models are tested.

The content of this article is structured in six parts: in the first part, the results of the literature review are exposed; in the second part, the

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 131-154.

theoretical elements that support the analysis performed are presented; in the third part, the methodology is described; afterwards, the results of the analysis are exposed, followed by a discussion and some conclusions.

Applied logic and ethics: the literature review

In the last two decades, a large number of articles and books have been published about applied ethics in different fields of knowledge and practices that involve controversial or dilemmatic moral issues. Among these areas are sustainability, interculturality, gender, the use of technology, health and death, etc. Some of these works make explicit the logics that accompany the applied ethics and refer to them in the following sections.

Deduction and principled ethics

The concept of "applied ethics" is often associated with a procedure that consists of establishing general principles defined in the field of academic ethics, from which codes of conduct and criteria for resolving dilemmas are deduced, as well as guidelines for distinguishing good and bad practices. According to Knapp and Fingerhut (2024), the concept alludes to the application of ethics in specialized areas or professions. Hirsch Adler (2013) makes explicit four principles that usually underpin professional ethics: charity (requires taking into account and legitimizing the achievement of certain goods and services), non-maleficence (orders to avoid physical, emotional and legal damage), autonomy (needs to guarantee the right of people to be informed and express their consent, as well as to be respected in their privacy) and justice (demands the rational distribution of resources, risks and responsibilities).

In the field of research ethics, the principled position of deductive cutting is also important (Aluja & Birke, 2004; Honorato *et al*., 2022). The principles mentioned are the same that apply to professional ethics, but with some additions such as merit and integrity in research (Koepsel &Ruiz, 2015) or scientific validity (Cruz *et al*., 2020). Some qualities derived from these principles are often emphasized, among them: respect for human dignity, confidentiality, transparency, care in the handling of animals, honesty, respect for intellectual property and social responsibility. It is usually assumed, without stating how it happens, that principles are internalized and constitute the "*ethos* of the researcher" (Koepsell and Ruiz, 2015; Bos, 2020). Also, in the field of research, the principles are considered necessary to make decisions and resolve dilemmas; from

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 131-154.

them lists of good and bad behaviors are established (Zúñiga, 2020), both in the development of research, as well as in the publication, editing and opinion of it.

Ethics applied to environmental problems also show a prevalence of deductive logic. Faria (2020) considers applied ethics to be a generic rational reflection on the relationship between moral agents and elements of the natural world. The author reviews several positions on this (anthropocentrism, biocentrism, holism, pluralism, animal ethics) and determines as a basic assumption for the deduction that human beings decide which non-human entities and processes are morally considerable.

The applied ethics that prevail in the field of technologies are principled and deductivist. Linares (2018) provides multiple arguments to justify this position, and points out that the extension of technological power has transformed the self-understanding of the human being and has imposed technological rationality whose imperative is summarized in the idea that everything technically feasible is morally justified and must materialize. The author opts for a moderate anthropocentrism and a hierarchical biocentrism, framed in four principles:

- Responsibility (which requires ensuring the existence of moral beings capable of being responsible).
- Caution (even without strong scientific evidence, it is imperative to pause or inhibit technological action that could generate transgenerational global damage).
- Protection of individual and community autonomy (without affecting the freedom of others).
- Distributive justice (of technological benefits and risks).

In relation to artificial intelligence (AI), González and Martínez (2020) also opt for a principled stance. From their perspective, applied ethics should contribute to solving ethical dilemmas, applying the following principles: respect and protection to people, guaranteeing their autonomy, avoiding harm, maximizing the benefits that AI provides and reducing the harm that it could cause.

Induction and analogy articulated to dialog and participation

On the other hand, in several fields of social practices, maxims or criteria are inductively constructed from the specific knowledge of the cases and contexts thanks to the participation of the people involved and the dialog to compare points of view, find similarities and differences, and reach consensus.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 131-154.

Some articles on research ethics reveal a logic other than deductive. For example, Darretxe *et al.* (2020) warn that any research process is an ideological and ethical choice, especially if research is to be inclusive. They argue for participatory research that involves a new profile of the researcher: someone who learns in collaboration with others, seeks social transformation, and is willing to abandon a position of power and control over the process. Calvo (2022) refers to a dialogic ethic open to reflection on principles, values, virtues, ends, and affections that guide and motivate people in particular contexts.

Of the recognized ethics in the environmental field: utilitarian, deontological and virtue ethics, Marcos and Valera (2022) bet on the latter, considering that, instead of a predictive knowledge, experiential and reflective knowledge is required. According to these authors, the idea of acting locally, thinking globally, makes it necessary to combine the study of nature with a virtuous act based on good inclinations, rather than general and abstract principles.

In the field of bioethics, Honorato *et al.* (2022) warn that the principle of autonomy is problematic when put in relation to issues such as euthanasia or the anticipated will. To make it effective, it is necessary to move from a paternalistic model of care to a participatory model; in the first, the doctor often undervalues the cognitive capacity of his patient and maintains the power of decision; in the second, information is offered to the patient and the opportunity to decide on his treatment, also determining value criteria. Vergara (2022), moreover, argues that the preparation for the good death is closely related to the sociocultural context.

For their part, in the field of social bioethics, Rojas and Nemogá (2021) consider that the recognition of the equality and dignity of cultures requires understanding the way in which each community handles its interdependence with nature. A similar position is maintained by Munguía and Mancilla (2023) when they point out that social bioethics seeks to solve social situations of injustice, based on the understanding of the identity and cultural diversity of native peoples, their perception of the quality of life and their relationship with the land.

The combination of deduction and induction

The combination of logical procedures is observed in the ethics applied to the treatment of some specific problems (environment, gender, diseases, technologies). For example, Salazar *et al.* (2020) argue that applied ethics seek to offer ethical philosophical reflections that contribute to the

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 131-154.

solution of moral problems in specific fields. For this to be possible, collaborative multidisciplinary work, involving experts and policymakers, is required. This form of applied ethics is concretized in public policies that consider power relations, which makes it essential to move from the abstract to the *empiric* sphere for the collection and treatment of particular data, and the recognition of diverse values and criteria.

Terrones and Rocha (2024) propose critical hermeneutics to discover the moral aspects involved in human activities. They consider that ethical initiatives are insufficient, especially in the field of AI, because mechanical compliance with codes does not imply regulatory questioning or motivate discussion about good practices. His proposal is procedural, dialogic, hermeneutic and critical.

Hence, even when applied ethics prevail in many fields of social practices, it is convenient to understand the particular contexts, promoting dialog and participation of those involved to arrive dialogically to ethical guidelines and criteria that contribute better to the solution of problems. This is more evident when considering that several of these fields refer to practices in a double sense: "They deal with human practice and inquire for the good of it" (Silva Carreño *et al.*, 2023, p. 192).

The theoretical references

Answering the question ¿what are applied ethics? has been a task undertaken by various authors since the 20th century. The discussion around this topic is also accompanied by positions around the logics that underlie these ethics.

On the status of applied ethics and their rationale

Oswaldo Guariglia (1996) refers to the difficulties and possibilities of applied ethics seen from the perspective of various theoretical ethics. First, it alludes to an anticognitivist or emotivist position that holds the impossibility of an applied ethics, arguing that a theoretical discipline cannot extend over such a great diversity of problems as those presented by concrete reality. It also refers to a cognitivist and universalist position that denies the possibility of these ethics considering that the theoretical level is general and consists of a few principles and rules of inference, while the specificity of the cases to which these principles apply requires an additional task of description and typing, which makes it necessary to have experts in each field of knowledge, which brings about leaving

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 131-154.

the field of ethics. From the position of Guariglia (1996), it is advisable to develop, through the study of each case and using a type of practical reasoning that expands its field of application through the analogy, a casuistry that would later serve for solving new cases.

This form of casuistry and other possibilities are critically analyzed by Adela Cortina (1993, 1996), to justify her own position. As a starting point, it is not one, but multiple applied ethics that "aim to guide action in everyday life" (1996, p. 120). She argues that, unlike moral ethics or philosophy whose purpose is to base the moral from theoretical or academic ethics, principles applicable to life, applied ethics are the matter of those who are valid interlocutors in moral issues that affect them in some area of social life. According to Cortina (1996), individual morals are insufficient to solve the problems of coexistence, therefore, it is convenient to construct cooperatively, in each problematic field of action, a frame of reflection that guides decision-making. This construction makes dialog and comparison of points of view indispensable.

Regarding the method of construction of these ethics, Cortina (1996) distinguishes three models that are insufficient and exposes the own. The first model responds to the deductive ideal and consists of a casuistry that "considers the concrete cases as a particularization of the general principles" (p. 122). It takes the form of the practical syllogism of Aristotelian style, but when arriving at the particular moment, it resorts to prudence. The flaw he sees in this model lies in the impossibility of having material principles that are universal. If it is needed to start from the beginning, he says, it has to be formal or procedural.

A second model coincides with the casuistic form referred to by Guariglia (1996). In this article, the principles are replaced by maxims, understood as "wise and prudent criteria for practical action" (Cortina, 1996, p. 123) obtained inductively by convergence of judgments that provide probability and are based on experience. The problem noted by Cortina (1996), lies in that when maxims come into conflict, it is often resorted to material principles accepted by intuition that do not ensure rational decisions. A procedural principle is required.

A third model upholds the procedural principle of discursive ethics: "are only valid those rules of action in which all those who could be affected as participants in a practical discourse could agree" (Habermas cited in Cortina, 1996, p. 126). The application of the principle is not simple: it requires strategic rationality and must obey a dialogic ethical principle, as if it were acted on in an ideal community of communication, which is problematic. From the ethics of discourse, Cortina says (1993),

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 131-154.

practical discourse is used to move from "I think" to "we argue". The values, principles or maxims and strategies are proposed considering those affected in each specific case. Although this model is necessary, it is insufficient if hermeneutic circularity is not used.

Hermeneutic circularity and the role of induction and analogy

We agree with Cortina (1996) and other authors in arguing that what corresponds to applied ethics is the design of the rational framework of application "which enjoys the circularity proper to critical hermeneutics" (pp. 127-128). It is a question of valid interlocutors, with the support of specialists in each field, finding principles of medium scope and values applicable in the problematic context in question, to achieve, in a cooperative way, a certain good, which usually requires the cultivation of habits or dispositions of the participants and the respective convictions, as well as the development of some strategy respectful of the values shared by those who participate.

The hermeneutic circularity interpreted by Villa Sánchez (2023), based on Ricoeur, is complementary to that presented by Cortina, because it gives an outlet to the problem of how the tension between principles—which are the basis of moral judgment—and convictions—which arise from conventions—is resolved. According to Villa Sánchez (2023, p. 168), the hermeneutic circle, typical of praxis, is made up of three moments: the good, the just and its application. Ricoeur points out that the way out of the tension between argumentation and conviction is not theoretical, but practical, and lies in moral judgment in this situation, i.e., in prudence. Thus, the tension between what is considered good (in a certain context) and just (with the pretense of universality) does not end in a confrontation, but in the need to clarify one and the other so that "the estimation as good and respectable attributed to the action falls to the agent of said action" (p. 180). It is the practical wisdom of the agent that must mediate so that "justice truly deserves the title of equity" (Ricoeur quoted in Villa Sánchez, 2023, p. 184). In this regard, it should be added that this mediation also occurs between the plurality of the community and the autonomy of the moral subject, as well as between the legality that crosses the institutions and the traditions of the community.

The importance of Ricoeur's proposal, Villa Sánchez says (2023), lies in the fact that it moves away from the ethics of Habermas and Apel's argument, insofar as it concedes that the reason it analyzes is always "an impure, contextualized, historical, communal reason" (p. 171), which at-

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 131-154.

tends to tradition and conventions or customs. At the same time, it moves away from contextualism, insofar as it meets the demand for universalization, considering that an "apology of difference by difference […] renders indifferent all differences insofar as it renders any useless discussion" (Ricoeur cited in Villa Sánchez, 2023, p. 171). More than a path of mere understanding, a dialectical process is followed that necessarily includes criticism. This is a critical consideration of the "coherence between language, thought and action that links states of mind, emotions and historicity" (Rodríguez Ortiz *et al.,* 2023, p. 235).

Although it is relevant for the subject of this research the broad justification provided by Villa Sánchez (2023) to Ricoeur's proposal (1996) around practical wisdom as an element of mediation, it is also convenient to consider that, when talking about applied ethics, such wisdom cannot be only that of a leader, an avant-garde or a group of enlightened people, but that of a reflective community that deliberates within the framework of a practical discourse, as Cortina proposes. This gives the process a political nuance.

It should also be borne in mind that the maxims or guidelines of medium scope have a problematic or conjectural character that – analogous to the hypotheses obtained by the logic of discovery (Beuchot, 2009) that includes induction, analogy and abduction – require for their application to address not only the common in several cases, but also the difference. As Beuchot (2009) states, it is in the dialog with others that arguments for and against are invoked, and a deliberation is made through *phronesis* (prudence). Hence the importance of this form of logic.

It is not, then, simply a question of applying certain principles to specific problems, but of constructing cooperatively maxims and strategies of action for achieving the common good. In this regard, Palazzi and Román (2005) consider that the search for solutions to new problems that arise in certain contexts, contributes to reviewing and recreating existing social morality (or ethnicity) and calls into question customary practices and ways of acting. Therefore, they affirm that applied ethics requires an open and critical conscience, as well as a willingness to take the risk of affecting interests. From their perspective, applied ethics entails a retroactive (over past mistakes) and proactive (risks are taken and projected into the future) responsibility, as well as the need to narrate. The latter requires the identity-otherness dialectic (Ricoeur, 1996; Silva Carreño *et al*., 2023) which includes self-recognition and recognition of the other.

The discussion on applied ethics that has been exposed, serves as a basis for adopting a different position from the principled and deductivist. In this position, maxims, understood as prudential criteria rather

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 131-154.

than principles, come to the fore. Induction and analogy are defined as logical procedures that are better suited to promote learning and the construction of moral convictions linked to context, rather than abstract principles imposed from outside. Dialectics mediated by prudence, rather than obedience to pre-established codes, also become relevant. This position is a consequence of the analytical-synthetic procedure carried out, which is described below.

Methodology

In this research, a qualitative approach of directed content analysis is applied (Hsieh & Shanon, 2005), whose starting point was the identification and elaboration of key concepts: socio-educational project, deductive logic, inductive logic, analog logic, hermeneutic circle. The analytical moment was followed by a synthesis procedure to articulate the logics with the ethics, examine their results and determine some patterns that can serve as criteria for further research.

The selection of the projects to be analyzed considers the following:

- A socio-educational project is defined as a set of activities planned and organized to provide an educational service in a non-formal way to a specific population group, which is generally socially disadvantaged.
- Each socio-educational project constitutes an educational device that includes objectives, goals, resources, strategies and rules of operation, although these elements are not always explicit.
- In socio-educational projects, different agents are usually involved that impose their imprint on the design and operation. Civil society organizations (CSOs) are frequently involved, but also public or private educational institutions and even government agencies. Of course, the population that is provided with the educational service also participates.
- The planning and design of the project does not always precede the activities that are launched; sometimes, the project is built along with its realization.
- An invariable feature of such projects is that they arise from the cooperation, agreement and willingness of those involved to meet certain objectives and rules. It is in the interactions that constitute these activities that the applied ethics are carried out and can be analyzed.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 131-154.

When examining the cases, the following questions were answered: who and how are involved in the project? What are the logical procedures perceived in the interactions? What is the role that the people involved in the project assume in relation to principles, maxims, moral criteria or guidelines?

The selection of cases was difficult because most of the articles reporting on socio-educational projects do not provide all the information required to answer these questions. Therefore, although more than thirty articles were reviewed, only twelve cases were selected that allowed to determine four classes of projects. The recovered articles report experiences of the last twenty years.

A first classification arose from the analytical process that resulted in a robust distinction:

- Those projects that were based on some previous code, a set of pre-established principles or a list of good and bad practices.
- Those who established, through dialog, the maxims or rules that the participants would follow.

In relation to the latter group, it was identified who participated in the determination of the maxims and if for this purpose the specific characteristics of the social group or community benefited were considered, if the maxims or rules were the object of collective reflection and discussion, and if in that process some general principle was taken as a reference. Problematic situations, if any, were also noted when applying the maxims in particular cases and how they were resolved. Contrast tables were prepared to organize the results of the analysis. The moment of analysis culminated with the articulation, in each case, of the underlying logics to the ethics that were identified. While the moment of synthesis consisted in the comparison between the cases analyzed to obtain a classification that we consider preliminary.

Results

The analysis and synthesis carried out based on the selected socio-educational projects allowed us to distinguish four classes of combination that are shown below.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 131-154.

Prescriptive ethics and deductive logic

Ethics is prescriptive when the principles determined by those who provide the educational service, derive in maxims and rules, according to which the process is carried out. This is often the case in projects where a good or benefit is granted subject to training or the handling of technical or ideological information. CSOs or government bodies are often involved in such projects.

Various government policies are embodied in such proposals. An example of these is the Productive Project Support Program for Family Heads: Morelos Women's Enterprises 2014 (Official Newspaper Tierra y Libertad, 2014). Its objective is to provide credit on preferential terms for the productive activities and self-employment of the heads of families of the state of Morelos to empower them and improve the quality of life of their families according to the criterion of equity. The program stipulates that each project should be submitted by groups of between 3 and 7 women, with the intention of promoting community development and contributing to the reconstruction of the social fabric. Technical training was provided to stakeholders to develop the projects. The results were not as expected because the groups were forcibly formed, their motivation was self-interested cooperation that did not contribute to community development and bonds of trust and reciprocity were not forged (Yurén, 2017).

As in socio-educational projects associated with other policies, in the case given as an example, the objectives and ethical principles are very abstract, and the strategy was prescriptive and inflexible. Also, the educational component was handled as conditioning rather than as a training opportunity and participation was passive and imposed.

Ethics of recognition and alternating logics

In five of the cases examined, the objectives and the educational strategy were established in advance by those who provided the service, as well as the principles that guided the project (justice, equality, inclusion, peace) and the maxims that guided the strategy. It can be considered, then, that the general framework was a deductive procedure, however, in each of these experiences dialog and intersubjective recognition were promoted, as well as the production of moral criteria or guidelines with conjectural nature, which allowed proposals to be made in relation to problems lived in specific contexts. In four cases (Caballer *et al*., 2022; Mijangos *et al*., 2017; Catalá & Perales, 2017; Rodríguez Roa *et al*., 2023) sought to fulfill an educational objective using art as mediation; in another case, the pro-

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 131-154.

cess was carried out within the framework of a service-learning program (Cortijo *et al*., 2022).

In all cases, respectful coexistence and empathic experiences were favored, as well as horizontal communication between participants, either to avoid violence (Mijangos *et al*., 2017), or to contribute to intercultural integration (Caballer *et al*. 2022) and social cohesion (Catalá & Perales, 2017). In particular, recognition of the other and trust were stimulated (Cortijo *et al*., 2022). These forms of interaction are attributed to the good results of those who report these socio-educational projects.

This was very clear in the project reported by Rodríguez Roa *et al*. (2023), where art was used as a mediation to achieve an ethical positioning in the face of violence. The strategy consisted of workshops whose purpose was to achieve, through artistic languages, reflection and awareness about the implications of violence in the environment and generate possible forms of resilience and action in the construction of peace. The dialogic, empathetic and creative process helped to sensitize those who participated: each one became aware of the ways in which he suffers and exercises violence and expressed a commitment to the construction of peace. The theme and objective of the workshops was given to promote a dialogic ethic, the recognition of self and the other, and taking a responsible position. In this way, the initial deductive logic gave way to induction and analogy, which favored the understanding of attentive listening and solidarity.

Dialogic ethics and logic of discovery

In relation to socio-educational projects, Corbella (2021) refers to some guidelines proposed by Martha Nussbaum and Amartya Sen: respect the individual freedom of the subjects; foster their agency to empower them; create, prioritize and enhance their capacities beyond their limitations; seek the active and equal participation of the agents of the socio-educational relationship; facilitate personal autonomy to avoid authoritarian and imposed actions; carry out individualized attention with special sensitivity to cultural diversity. Although the author refers to "principles", we consider that these are more rules obtained inductively from various projects in which dialog and agency constituted the basic educational strategy.

This combination can be observed in projects where the learning community strategy or similar was applied, favoring that the beneficiary population participated from the beginning making decisions in relation to the tasks and objectives. In the words of those who report one of these experiences (Astorga *et al*., 2023) it was sought to carry out an

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 131-154.

action-research process where the co-construction of knowledge with its own senses and purposes, recognition under the forms of love, equality and social esteem, and the validation of work by those who participated was carried out. In another case (Cavallo, 2022) a dialogic-participatory methodology was favored for adults and young people to develop skills and attitudes in workshops organized according to their interests, stimulating self-management. In a third case (Vargas *et al.*, 2021), education in interculturality and reflection on moral dilemmas were sought to combat discrimination and racism. A playful strategy was applied, and although participation was not achieved from the beginning, it was made possible throughout the process so that children made proposals to adapt the general plan to their interests.

A complex project, which lasted several years and had various variants, started with the intention of helping migrant day-laborer mothers to stimulate their children's schooling and initiate a lifelong learning process themselves. The experience reported in the first year (Yurén & De la Cruz, 2011) showed that the flexibility of the device, a mediation marked by intersubjective recognition and openness to dialog, were the opportunity to work on various topics of interest to the participants (gestation, learning, justice, good coexistence, education of minors, among others). The interactions increased the interest in learning. The women reflected on their relationship with the institutions and made plans for the future; they recognized themselves as learners and found the possibility of taking on the role of teachers in an experience in which each prepared a presentation with slides to teach others how to make a dish (mole, flan, donuts, tortillas, etc.). There was also a time when the participants organized a cohabitation to give back to those who served as educators.

The cases described here reveal processes in which the understanding of the particular context, the dialog and the proposals of those who participated were favored, both in the determination of the criteria and guidelines of action and in the implementation of the activities to meet the objectives of the respective projects. Situated cognition and activity in the process of learning, together with work with and for others, contributed not only to the fulfillment of educational objectives, but also to the formation of a supportive and tolerant consciousness. Induction and analogy structured applied ethics.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 131-154.

Prudential ethics of critical hermeneutics and dialectical logic

Going through the different moments of the hermeneutic circle is not easy and takes a long time. An example of this is a socio-educational project developed since 2010 by several OSCs, in collaboration with indigenous communities in Sierra de Jalisco, Mexico. The project, reported by Lobo and Yurén (2023), aimed to support the process of transformation of Wixaritari communities into extreme poverty and marginalization in their effort to achieve social, environmental, economic and cultural sustainability, in response to their needs and taking as a starting point access to drinking water. The Ha Ta Tukari ("Water, Our Life") project began when representatives of the La Cebolleta community and OSC Isla Urbana and ConcentrArte made a commitment to work together to install rainwater harvesting systems in the mountains. Over time, collaborators and volunteers joined this network of actors. The network activity required multiple agreements and an organization articulated by empathetic relations, reciprocal ethical recognition and a common purpose (Lobo & Yurén, 2023).

Once progress was made in meeting the need for access to water, other needs arose that demanded new activities. The intervention strategy was designed and developed in two intertwined lines: education and community empowerment. Workshops were implemented to promote the development of skills required in specific tasks, and activities were carried out that allowed participants to configure their own notions, identify the social and environmental problems that affected them and develop capacities to overcome them through resilience, artistic expression and joint work.

The intervention method, called "The Infinite Window" (Lobo & Yurén, 2021), has an integrative character (it allows the participant to exercise their multiple intelligences) and sensitive (it favors a creative-artistic process that integrates perception, sensations and feelings); it leads the participants to recognize themselves in relation to their social and natural environment, giving them tools to face their problems and improve their living situation. It is playful and flexible, its basic postulate holds that artistic creation is a generative agent of social transformation, because art is, in itself, a process of transformation.

To implement the socio-educational strategy, diagnosis, monitoring and periodic evaluation were necessary, which were carried out in a dialogical way. At various times, collective debate and deliberation were required to recognize needs and what needed to be changed, as well as to

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 131-154.

generate strategies for change and implement them. Narratives from the participants were also gathered, which were the basis for adjustments to the designed programs.

The implementation of the socio-educational strategy set in motion the dialectic between the particularity of the community—uses, customs, sense of belonging and affective ties—and the universality of human rights. It also made possible the articulation between the participants, which meant erasing hierarchical and cultural boundaries, and combining respect for tradition with innovation to restructure spaces and productions. It also stimulated criticism of existing ethnicity and favored autonomy and empowerment of the community, which allowed its members to take a stand against formal and informal powers.

The observed transformations allow us to affirm that those who integrate the network (OSC and community) have responded, through their activity, to a pragmatic objective (promoting access to drinking water) according to an axiological requirement of sustainability and autonomy. The instrumental logic gave way to a communicative logic (Habermas, 1989) and the community and its members have become more autonomous and involved; children and women were made visible, spaces of expression were opened for them, and peer support networks were created. Women became interested in learning more about their bodies and gestational processes, as well as the care they required; they are now accessing elected positions and participating in decision-making that affects the community and their lives. To date, the wixaritari communities continue in their transformation process.

The prevailing logics in this long process were the induction and analogy, which structured participation, dialog and understanding of the sociocultural particularity, without undermining the subjection of the good (values, norms, practices, customs) to the analysis and opinion of moral judgment supported by principles with universalist pretension (justice, equity, autonomy), to finally overcome the "practical bottlenecks" through practical or prudential wisdom.

In this long process, multiple learning and skills have been generated, both in the Wixárika population and in the members of the OSCs. These achievements, together with the solution of environmental and social problems, also contributed to an exercise of understanding of oneself and others, and of moral self-monitoring, which is reflected in the activities developed in favor of present and future generations, in their relationship with nature.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 131-154.

Discussion

What the literature review showed is that, in relation to the applied ethics in different fields, there is a tendency to fundamentalism far from the critical hermeneutics and the dialectics that it involves. However, in socio-educational projects this trend is lower. The experiences of different groups seem to have influenced a way of working that favors participation, dialog, understanding of the particular and activity based on criticism.

Some implications are inferred from the cases examined. First, there is no biunivocal relationship between the ethics applied to socio-educational projects and the logics that give structure to the activities carried out. Second, the validity of applied ethics does not depend entirely on their logical structure, but this contributes greatly to the quality of the results and the process followed.

When hermeneutic circularity and dialectical perspective are sought, knowledge and understanding of particularity are invariably included to proceed inductively and analogically (Beuchot, 2009; Villa Sánchez, 2023). This opens avenues for the realization of ethics that overcome the prescriptive and often ineffective rigidity of deductivism.

The combination of hermeneutic circularity with induction and analogy contributes to good learning and the constitution of moral consciousness. This is because, on the one hand, induction and analogy support the dialog and the search for consensus that are indispensable for the construction of prudential maxims or criteria, as well as strong convictions (Cortina, 1996; Ricoeur, 1996). On the other hand, these logical procedures require working in specific contexts on real problems and situations, the solution of which requires collaboration with others. In other words, it not only demands the cognitive activity of learners, but also requires a "situated cognition" that confers relevance to learning and enriches it by social activity (Díaz Barriga & Hernández, 2002).

Conclusions

The main contribution of the work carried out is to show that the combination of induction and analogy with certain ethical perspectives has favorable effects on learning and on the formation of the moral conscience of those who participate in socio-educational projects.

Four classes of combinations are distinguished, and it is concluded that the best results are due to the incorporation of inductive logic and analogy in educational processes. When the objectives, rules and inter-

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 131-154.

vention strategy are established beforehand and there is no time for dialog and co-construction between those who educate and those who will be educated, then the results usually have less educational impact than that of projects built and developed cooperatively. Something what happens frequently in non-cooperative projects is that the group of learners is seen as something homogeneous, without considering the differences of the participants. The result is often below the expectations of the project designers.

It is concluded that, analogous to what happens in the production of scientific knowledge, two basic logics operate in the production of principles, maxims and guidelines for moral behavior: the first is to deduce from principles, justified in some way in some institutional field (academy, church, party, among others), the norms, values and guidelines that are considered ethically valid; the second is the logic of discovery that consists in seeking the understanding of particular problem situations and, through induction and analogy procedures, arrive at the formulation of maxims, valuable purposes and guidelines of ethical behavior for the practical solution to the problems faced; active participation in this process is translated into convictions. Although the first of the logics is the most helped because it gives the impression of ethical soundness, in the educational field it has limited results because it does not require great activity of the learner. The second path, on the other hand, involves situated cognition and greater activity of the learner, which ensures better learning (Díaz Barriga & Hernández, 2002), while guaranteeing strength in moral convictions (Cortina, 1996).

It is recognized that the main limitation of this investigation is the low number of cases analyzed, largely because the description of the projects is often insufficient for their analysis. In future research it will be useful to highlight more clearly how the inductive procedure and analogy are carried out to generate criteria and patterns of moral behavior that correspond to assumed convictions. That will require observational work and interviews focused directly on revealing that process.

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Conceptual Construction in Physics Using Inductive Teaching Methods

Construcción conceptual en física a través de métodos didácticos inductivos

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Abstract

This contribution shows the development and evaluation of an educational process with mathematics teachers in training, focused on the use of teaching strategies with inductive characteristics, in Mathematics and Physics subject of the Bachelor's Degree in Mathematics Teaching at the University of Colima, Mexico. The experience includes 19 students, who have had disciplinary training in mathematics and master the procedural knowledge and algebraic language involved in Physics at the basic levels, but they have had little access to conceptual knowledge of both classical physics and modern physics. With this principle, the course focused on reflection and problem solving. From this logic, the proposal included searching for both the procedural and conceptual domain, this second one is the central objective of this research. The inductive methods included the use of audiovisual materials and readings that go more in the order of dissemination. The results of their work show that, without omitting a more traditional training process, such as problem-solving or classic physics textbooks, the incorporation of inductive strategies focused on the concepts like "motion" or "light" allows for a deeper understanding of fundamental principles, serving as a functional complement for a more comprehensive understanding.

Keywords

Conceptualization, Inductive Method, Teaching Strategy, Scientific Dissemination, Physics, Evaluation.

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Resumen

El presente texto muestra el desarrollo y la evaluación de un proceso educativo con profesores de matemáticas en formación, centrado en el uso de estrategias didácticas con características inductivas, en el marco de la asignatura Matemáticas y Física de la Licenciatura en Enseñanza de las Matemáticas de la Universidad de Colima, México. La experiencia incluye a 19 estudiantes que han tenido formación disciplinar en matemáticas y dominan el conocimiento procedimental y el lenguaje algebraico que implica la física en los niveles básicos, pero con poco acercamiento al conocimiento conceptual, tanto de física clásica como de física moderna. Bajo este principio, el curso se centró en la reflexión y la resolución de problemas. Desde esta lógica, la propuesta incluyó buscar, tanto el dominio procedimental como conceptual, siendo este último el objetivo central de esta investigación. Los métodos inductivos incluyeron la utilización de materiales audiovisuales y lecturas que van en un sentido de divulgación. Los resultados de sus trabajos muestran que, sin omitir un proceso formativo de corte más tradicional, como la resolución de problemas o libros de texto de física clásicos, la incorporación de estrategias inductivas sobre las particularidades de conceptos como "movimiento" o "luz" permite una comprensión más profunda de principios fundamentales, siendo un complemento funcional para una formación más integral.

Palabras clave

Conceptualización, método inductivo, estrategia didáctica, divulgación científica, física, evaluación.

Introduction

The idea of rigid boundaries between the social sciences, the experimental sciences, and the humanities has been left behind. While it is clear that the objectives pursued by these areas of knowledge are different and the ways to learn their contents are also different, in recent decades there has been a debate with greater openness about the social and human implications behind the construction of scientific knowledge also in the experimental sciences, in the case of this contribution, physics. Intercultural science, ethnomathematics, scientific enculturation or mathematics and sciences for citizenship and human rights, are some examples, among many others, of emerging lines of research in this regard.

The objective of this study is to evaluate and make visible the effectiveness of using inductive didactic strategies to strengthen conceptual understanding in topics related to physics, emphasizing how this type of approach can contribute to a more comprehensive and meaningful learning. In this sense, the proposed strategies, without neglecting more conventional activities such as specialized reading or text-based problem solving, are incorporated to help overcome the limitations of processes focused solely on the procedural or technical skills of physics. The methodology of analysis was based on the approaches of Ahumada (2005) regarding the construction and evaluation of concepts.

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This research is carried out within the framework of the Bachelor's Degree in Teaching Mathematics, a degree attached to the Faculty of Educational Sciences of the University of Colima. This program aims to train professionals capable of addressing challenges in teaching and learning mathematics, promoting mathematical literacy and didactic innovation with a social responsibility approach.

The particularity of the program is the integral approach between a training in the disciplinary area of mathematics, a training in the pedagogical disciplinary area and a third axis that refers to specific didactics on arithmetic, geometry, probability and calculation. The majority of those who have graduated have joined as teachers at the basic levels and at the upper middle level, a few cases at the higher level. Those of us who participated in this program as professors have been able to realize that many of these job additions of those who graduate, are not only due to the specific need for staff trained in mathematics by the applicant institutions, but also for related subjects, particularly physics. This has then become a specific need of the program.

Although the participating group had detected a strong mastery over solving problems involving mathematics and physics with respect to the algebraic domain, this intervention focused on overcoming the common limitation of approaching conceptual understanding as simple memorization of definitions. Instead, the construction of concepts as a dynamic and evolving process was promoted. This approach seeks to equip future teachers with stronger tools to foster comprehensive scientific literacy.

The methodological proposal is inserted in a formation that transcends the domain of mathematical algorithms, integrating characteristics of the student population. While these students have a strong background in mathematics and pedagogy, their knowledge of basic sciences, particularly physics, was limited to superficial and brief previous experiences that had not been linked to mathematics in any meaningful way. In this context, where we want to promote meaningful learning and scientific literacy, using inductive methodologies favors and is in tune with educational trends that seek to integrate theoretical and practical knowledge, as reflected in various recent research and which will be mentioned later.

It is here that the proposal of work from inductive strategies for the understanding of specific concepts of physics is considered as a relevant strategy. Thus, the implementation of inductive activities was carried out with 19 students of the University of Colima, including the observation of

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audiovisual materials, informative readings and direct experimentation, organized in seven thematic blocks such as movement and light, among others. This work methodology, which includes principles of constructivist approach, encompasses an epistemological approach based on the fact that the construction of knowledge in physics—in this conceptual case—must consider basic or experimental sciences as a human activity, which cannot be disconnected from the sociohistorical conditions in which such knowledge has been, and continues to be, created (Díaz, 2013).

From here, the thematic discussion through historical readings, dissemination of science, the use of audiovisual materials and specific experimental activities that make links, both implicit and explicit to the concepts in question, promote in the student thought and conceptual construction beyond the memorization of encyclopedic definitions.

This paper first presents a position on the construction of knowledge in physics, followed by a theoretical definition of inductive didactic strategies. The methodology is described below, highlighting the use of scientific and audiovisual dissemination materials as didactic resources. Next, the implementation process of the proposal is detailed, accompanied by evidence of its application to finally present the results obtained, along with a discussion that includes possible guidelines for further research.

Building knowledge in experimental sciences

Although it is not the intention to conduct an in-depth debate on the universal or local construction of knowledge, it is considered important to mention a debate already systematized in greater depth in another contribution made by Díaz (2013), regarding the well-known discussion between Charles Taylor and Thomas Kuhn at Lasalle University. Knowing the complexity of this reference, only some of its fundamental postulates are included. According to Taylor, the construction of knowledge in natural or experimental sciences cannot have a hermeneutic basis, as it is based on the study of data independent of the historical and sociocultural context. Natural world objects of study, for Taylor, are independent of human interpretation processes.

On the other hand, Kuhn argues that the scientific work, also that performed in the experimental sciences, is an intrinsically human activity, influenced by beliefs, prejudices and specific cultural systems. In this sense, the interpretation of natural phenomena is closely linked to the previous experience of each person, so it is crucial to distinguish between

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objects of the natural or physical world and the meanings and interpretations that are assigned to them according to their use. This is clearly seen in astronomy, where stars have had specific cultural meanings throughout history, but have also served practical applications such as construction, time measurement, and orientation.

If one thinks of concepts that are now basic in physics such as temperature, light, electricity, or friction, the discussions must have been very different depending on the geographical or cultural context where they were generated. Would the same questions be asked about friction by those who had ice as a daily element over those who lived in deserts? Would they reach similar conclusions? Probably not. It can also be thought that, in the current epoch, with so much information available in real time, it is difficult for these ambiguities to happen, however, the case of Pluto can be resumed, because according to recent conclusions, it has ceased to be a planet. Interpretations and parameters continue and will continue to change.

This is not intended to deny or ignore the universal elements of knowledge in physics, but to emphasize that this knowledge is the result of multiple discussions, experiences and particular contexts that had an influence on those who contributed to the discoveries and systematization of knowledge. This process is commonly overlooked in educational processes that limit themselves to memorizing definitions presented as absolute truths in educational books, and shows that knowledge in physics is dynamic, unfinished and constantly under construction.

To mention one example, understanding a widely accepted principle such as the "law of universal gravitation" does not require each student to "rediscover" it as a condition for understanding it, but it does require understanding its formulation processes, the historical and cultural conditions that facilitated its formalization, as well as its current applications. It is in this context that the inductive approach presents as a tool that can enhance the transit of particular situations to the understanding of generalities, not only in fundamental concepts such as gravitation or movement—as will be explained later—but also in other areas of knowledge. This approach allows those who study to establish significant connections between the theoretical and the practical, favoring a conceptual construction adaptable to various topics and levels.

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Inductive didactic strategies

In a very general way, the inductive-deductive method consists of two opposite processes. Induction refers to a way of reasoning moving from situations to more general knowledge, which in turn reflects what is common in particular situations. It is based on finding the common characteristics to arrive at generalizations that have an empirical base (Rodríguez & Pérez, 2017). For authors like Dávila Newman (2006, p. 184), inductive reasoning favors accumulating knowledge from particular experiences, while deductive reasoning helps to organize this knowledge in a more general panorama.

Both deductivism and inductivism pose the same problems. In both cases, the starting point is to indicate a method or strategy that allows general statements to be justified to an undefined number of cases—or universal generalities—while justifying a cognitive value (Andrade *et al.,* 2018). Inductive reasoning is not only useful within research processes, but also allows links between observation and theory or formalization.

There are several advantages from the construction of knowledge that various authors point out for methods or inductive strategies. Repetto (2024) or Moreno and Corral (2019), refer to the fact that one of the potentialities of this type of strategies is that they not only seek the abstraction of general patterns, but also promote contextualized learning, an understanding of local reality and the development of critical dialogs. For their part, Palmett (2020) and Monroy (2004), highlight the consolidation of new knowledge from the observation and systematic recording of particular phenomena from the empirical. This collection of data within the inductive process allows generating inferences that can later be compared with existing theories.

Induction allows the transition to knowledge based on information that initially seems isolated (Álvarez & Alonso, 2018). This is related to the previous section. If we start from the idea of observation as something that is not limited to the act of sight, but as the trigger for reflection and analysis, the isolated information can serve as components of a specific mental object or in the case that interests in this contribution, a particular concept.

The position of this intervention does not consider that the starting point of the deductive is something negative or that it cannot contribute to the conceptual construction, however, an approach of this type does not refer to all the previous elements involved in the construction

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of a conjecture (Morales, 2008), or in our case, of a specific physical concept. From a teaching inspired by constructivist positions, starting from everyday and particular situations it responds with much more coherence to the process of non-universalist conceptual construction that is wanted to achieve, conceiving the multiple ideas and circumstances that lead to that knowledge. In this sense, if overcoming the idea of objectivity as the main goal in physics or any other experimental science, inductive strategies or methods are useful to minimize subjectivity or relativism in the teaching-learning process (Rivera *et al*., 2024), as they are supported by observations and concrete experiences that allow a deeper and more meaningful understanding of concepts.

In other words, teaching concepts such as a list of definitions and problems or exercises linked to these concepts, such as reconstruction processes or mechanical imitation of what the teacher previously performs or resolves, rarely constitutes a cognitive challenge for the learner. Following with Álvarez *et al*. (2018), from the application of inductive strategies, it is suggested that teachers carry out a kind of "training" towards their students, locating the existence of ideal objects (abstractions) and real objects (physical) to be able to establish the relations between both.

In this sense, it should be noted that part of the proposed methodology with the group of students does consider experimental observation, practical activities that implicitly contribute to the conceptual construction, but is not limited to this. The inductive strategies used, in addition to the experimental activities, involve a series of readings with an informative approach and the use of audiovisual materials, some explicitly designed as outreach products, but others more focused on popular culture, which is explained in greater detail in the next section.

Methodology

This section, which explains the main part of the strategy, does not attempt to go deeper into the definition of scientific dissemination, but does mention, in a general way, some key differences between this and other activities such as scientific dissemination, as well as pointing out its main characteristics. The dissemination and dissemination of science may have similar purposes and methods. But while outreach is about more peer-to-peer communication, it seeks to reach a broader audience, something that originally seemed to be reserved for a minority (Vargas, 2018).

Continuing with Vargas (2018), it is implied that in addition to the knowledge to be disseminated, the strategies and the means to do so, the-

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re is a definite recipient. This last element implies considering that the target population should be defined according to its interests, should be fully committed to that population and should select – finally and responsibly – the material and quality of the information. This last aspect highlights the elaboration of structured questions that attract attention and show the relevance of the topic.

It might seem unusual for undergraduate students with a solid background in mathematics to be considered a suitable population for developing science outreach strategies. However, it is precisely in this context that such materials and the triggering questions of discussion become relevant. As mentioned, the main problem identified in this group was their limited conceptual mastery of physics; the above derived and also corroborated by their testimonies, as well as the observations of several of their teachers. They had little contact with these topics, particularly from the constructivist approach that is sought in this work, i.e., to encourage the conceptual construction for its future teaching. It is important to note that, although this contribution focuses on the conceptual approach, the mechanized mathematical processes related to each topic were also integrated into the sessions as a complementary part.

The informative readings used were very varied, but as an example two recurring books can be mentioned and also circulate freely on the Internet: *For the love of physics* (Lewin, 2012) and *Big questions-physics* (Brooks, 2011). As for the first, whose author was known for his dynamic classes and various experiments at the Massachusetts Institute of Technology (MIT), he uses everyday natural phenomena such as rainbows or waves emitted in water when throwing a rock, in addition to simple technological contributions such as elevators or simple scales to illustrate physical concepts. In the words of its author, the objective is to be able to observe what surrounds us in a different, profound and appreciative way. As for the second—unlike Lewin's descriptive, anecdotal, and experimental style—Brooks starts with simple questions about everyday phenomena and how these kinds of questions led to some of the deepest discoveries in physics. From simple elements such as light or rain, they try to answer questions about the nature of time or the laws of physics. The text also mentions biographical parts of great thinkers of physics such as Newton or Maxwell considering the context in which their discoveries were made.

In a different way, both Lewin and Brooks use analogies as a constant resource, making comparisons in hypothetical situations that could hardly occur to us, such as falling from an elevator or a building, with situations

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 155-188.

that we commonly live, such as getting on a scale or tripping. In this sense, Lima and Gómez (2024, p. 108) say that analogies are extremely useful for understanding abstract concepts, in addition to low-cost materials and easily accessible resources, which are an ideal bridge to approximate theoretical conceptual construction to everyday or recognizable situations for students. Both, the use of analogies and the use of low-cost materials are transversal to this proposal, since they are incorporated, respectively, in the dissemination readings and in the experimental activities.

As for the audiovisual materials used, these were much more varied. Explicitly popular documentaries were used, for example, such as the series *Cosmos: A Space Odyssey* (Druyan & MacFarlane, 2014) and *Genius by Stephen Hawking* (Bowie, 2016). However, one of the most innovative parts was the inclusion of audiovisual that, in the first instance, can be considered as pure entertainment, but that, being part of pop culture, is an excellent trigger for the discussion of physical concepts. In this sense, films with explicitly scientific plots such as *Gravity* (Cuarón, 2013) or *Tesla* (Almereyda, 2020), as well as superhero films, action films or even cartoons come in. Why including such products?

Some years ago, based on research on social imaginaries through cinema as a didactic resource, I argued about the educational potential of films considered entertainment. In another era it was believed that television and cinema educated or rather "poorly educated", but in recent decades, this perception or prejudice has been diminishing, in part, because now that negative connotation has social networks. This perspective has continued to evolve and authors such as Casallo (2024) refer to the positive impact of audiovisual narratives—in their case from anime—as a vehicle for students to perceive and experience situations that promote personal reflections and critical thinking. In the case of inductive strategies, these products can support the construction of meaning and understanding from observing and discussing concrete experiences. These types of narratives linked to science fiction, although far from possible scientific or technological elements such as time travel, teleportation or any "superpower", are the ones that have been used most for teaching. Why? Most likely, beyond their popularity, it is because, presenting clearly implausible elements from the scientific facts, they are precisely an excellent excuse for counter-argumentation (Cuevas, 2020).

Why cannot anyone run like *The Flash* does in its latest film adaptation (Muschietti, 2023)? Why is it impossible to fight two creatures like King Kong and Godzilla as can be seen in the most recent film of these

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characters (Wingard, 2024)? Why cannot there be explosions in space as seen in *The Rise of Skywalker* (Abrahams, 2019)? Why can one travel to the future as Stephen Hawking say, but not to the past as in the *Back to the Future* (Zemeckis, 1985) or *Terminator* films (Cameron, 1984)? These ideas, so accepted while being observed on screen, but so far away when we discuss them as something really possible, are simple to compare with technology and known science, therefore, they require precisely a minimum of notions to be refuted, especially when discussing in introductory courses to scientific disciplines or with students of basic levels, level where future teachers who participate in this intervention are expected to be inserted at work.

Participating Group

Nineteen students, 7 men and 12 women, participated in the Bachelor's Degree in Teaching Mathematics at the Faculty of Education Sciences, belonging to the sixth and eighth semesters. It should be noted that the subject is optional, so in the first instance all participants were interested in the subject over other options linked to didactics.

The process took place in the period January-July 2024. The subject, as mentioned above, does not correspond to an in-depth approach to physics, since, within the same institution, especially in the Faculties of Science and Engineering, courses on these contents are given that cover several semesters. It can be considered an introductory course at the disciplinary level, but emphasizing didactic processes for future teachers of basic and upper middle levels.

Materials and phases of the intervention

The group participated in its entirety throughout the process and the themes were divided into seven blocks:

- Measurements and inaccuracies
- Newton and the movement
- Conservation of energy
- Electricity
- Magnetism
- Light and color
- Relativity

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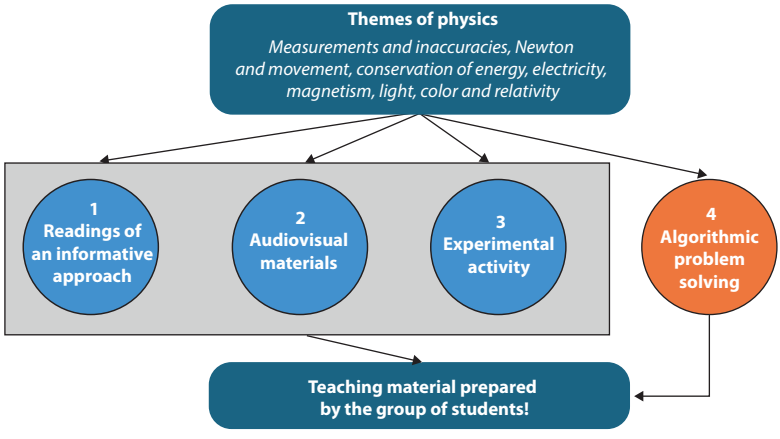
For illustrative purposes of this contribution, it is chosen, as a *corpus* of analysis, regarding the theme of movement and the theme of light and color, one of the initial themes and one of the final themes, respectively.

The methodology used for the entire course comprises four phases per block. The first has to do with the conceptual, historical and contextual understanding of each central concept of the topics; the second has to do with the observation of audiovisual materials on the same topic; and the third has to do with the axis focused on the resolution of problems of a mathematical or algorithmic nature. At the end of each of the topics, the students elaborate a mini-project with what they have learned, with the slogan that it is a replicable teaching material for teaching. The elements of the intervention are summarized in Figure 1.

Figure 1
Phases of the intervention process



Before addressing the conceptual construction and its methodology of analysis, it is important, once explained the cut of the *corpus* of analysis to two themes and the final work of the group of students, to briefly describe the readings, audiovisual materials and experimental activities that covered the theme of movement or Newton's laws, and the theme of light and color, in the order that have been mentioned.

Approach to Newton's laws from the disclosure reading

The detonating reading for the concept of movement and related to Newton's laws was "Bodies in motion" from the book *For the love of phy-*

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sics (Lewin, 2012). From an anecdotal and historical perspective, the author covers four main sections. The first refers to the law of inertia or "Newton's first law", where a situation arises that precisely favors an inductive approach. When have we seen a body in permanent motion, without it stopping?

While half of this law seems to be something common, i.e., that a body remains at rest until another force acts on it, it is the second part, i.e., that an object in motion will continue like this until something stops it, where it costs more work to think about the common, because it is difficult to remember such an example. It is here that inertia turns against intuition, according to the author. We have not seen things move in a straight line indefinitely.

This makes the reader think and reason. Concepts such as friction appear, activities such as ice skating are named. From this point the discussion of particular activities or phenomena is favored towards more general conclusions. The sections of Newton's second law (*force* = *mass* x *acceleration*), the confusion between mass and weight, and free fall follow this same logic in the material. Once the central concepts of movement from reading were already introduced, we proceeded to work with audiovisual materials where Newton's three laws could be illustrated in a more dynamic and above all visual context.

Approach to Newton's laws from audiovisual materials

Snippets from the superhero films *Antman* (Reed, 2015), *Captain America: Civil War* (Russo, 2016) and *Avengers: Endgame* (Russo, 2019) were used, the main images of which can be seen in Figure 2. The fragments were three. The first focused on the character's "shrinkage," which led, outside of the unreal possibilities of the plot, to understand the implications of size with respect to the character's movement, as well as its relationship between weight and mass. The second segment, in the same sense of the discussion, focuses on the giant version of the character. Finally, the third segment focuses on the fight between all the superheroes of the Marvel movies, where they undertake a race from the same starting point, some by flying, others by running, others by swinging and also appears the character Antman of the other segments in his giant version, however, all seem to move at the same speed, trigger element of the discussion.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 155-188.

Figure 2
Movie snippets for the motion theme

Source: taken from Reed (2015) and Russo & Russo (2019).

The second audiovisual element is the film *Gravity* (Cuarón, 2013). Although it is also considered a film of great audience and multi-awarded, the interest lies in asking the group of students to freely locate elements referring to Newton's laws, and whether these are presented correctly or not, arguing in all cases. Gravity, inertia, movement, maneuvers and strategies of the characters, collisions, disintegrations, pressure, decompression and vacuum, are some of the concepts that can be identified and discussed. From the identification and discussion of these already visible concepts, we proceed to experimentation.

Approach to Newton's laws from experimentation

The experimentation in this block was a series of simple activities. The first referred to replicating the experiment attributed to Galileo and the tower of Pisa mentioned in Lewin's first reading, limiting itself to throwing objects with different shapes and densities from a rooftop and analyzing what happened in each case or comparison. A second experiment involved the use of Newton's pendulum and observing why the law of inertia seems not to be enforced, and finally, the use of a rubber rocket to discuss Newton's second and third laws. A third experiment consisted of a speed challenge, which involved walking as fast as possible (without running) for 3 seconds, trying to find the best technique to

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 155-188.

cover as much distance as possible. Once found, it was proceeded to argue the reason of the achievement, and the discussion focused on speed, time and distance traveled.

Approach to the concept of light and color from the dissemination reading

The detonating reading to discuss the concepts of light and color is "above, below, inside and outside the rainbow" (Lewin, 2012). Following the style of concrete and everyday experiences observable in both nature and human activity, the author starts from a personal experience about points of light on his wall, formed by sunlight through the leaves of a tree and how something so simple can generate wonder.

The rainbow is a central element of the text, where the author speaks from a historical perspective about the fascination in scientists like Newton and Haytham with phenomena related to light. The three conditions that are required for a rainbow to be generated are narrated from here: the Sun must be behind the observer, there must be rain in the sky and there must be no clouds that block the light. The diffraction phenomenon is mentioned from the understanding that the (white) light that passes through the water droplets decomposes into the visible colors that our eyes can capture. After a few simple calculations to know the distance and height of a rainbow, he finally mentions some practical tips for searching for rainbows, something that is taken up in experimentation activities.

Approach to the concept of light and color from audiovisual materials

Episode 5 of the *Cosmos* series*: A Space Time Odyssey* entitled "Hidden in Broad Daylight" was used as audiovisual material, which focuses on the exploration of the wave theory of light and how it has been studied throughout history, passing by philosophers such as Mozi or the Arab scientist Ibn Al-Haytham (mentioned in the previous reading), who was among the first to study the nature of light and laid the foundations for the later invention of the telescope.

Another important block of the documentary is the mention of the work of Isaac Newton and his demonstration that light is composed of a visible spectrum by experiments with diffraction through prisms. Von Fraunhoer's work on the spectral lines of visible light and their relationship by the absorption of light by electrons is also addressed. Fo-

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 155-188.

llowing this historical perspective and discoveries, it ends with the bases of astronomy and how we have been able to observe the stars and planets, see their composition, as well as understand the movement and expansion of the universe.

Approach to the concept of light and color from experimentation

The experimentation of this block, unlike the aforementioned movement block, did require very specific materials for its conduction, in addition to some basic infrastructure conditions such as dark spaces. It was divided into three, one for each phenomenon linked to light and color addressed in both the audiovisual material and the detonator reading. A series of experiments linked to reflection, others linked to refraction and others linked to diffraction of light. It is important to note that part of the inductive process refers to not starting from the concepts, but, from this series of experiments; the group of students must identify the properties and characteristics of each observed phenomenon and subsequently draw comparative conclusions. From there, one can then deduce each of the three concepts (reflection, refraction, diffraction).

As for the reflection of light, this is probably the most well-known or everyday of phenomena, since, in the words of the students, we all see ourselves reflected daily in a mirror at least once. However, the activity includes something not so everyday, such as the use of laser pointers and some curved prisms and mirrors as seen in Figure 3, an element that makes visible the changes in the direction of light. In addition to this, an activity is added with a pair of simple mirrors while increasing or decreasing the angle between them, while analyzing whether the reflections or projections of the images seen in the mirrors are increasing or decreasing in number, as shown in Figure 4. For the case of refraction, the experiments are very simple, since they only involve containers of different shapes, mainly spherical and oval, to compare how an object looks in real and apparent situation, similar to when we introduce a straw to a drink, or how an object enlarges when seeing it through a spherical fish tank, alluding to our eyes through a magnifying glass.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 155-188.

Figure 3
Laser activity

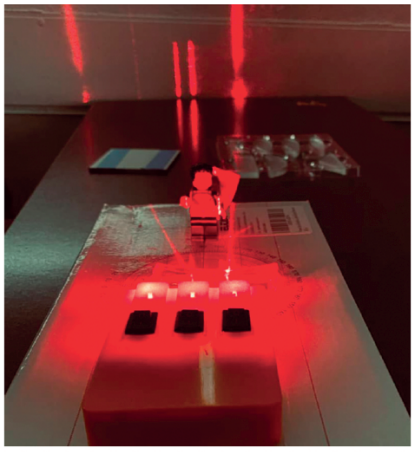

Figure 4
Activity with mirrors on reflection

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Finally, in the case of diffraction, experimentation is somewhat more extensive and sophisticated in terms of specialized material, but at the same time low cost (Figure 5), since this concept or phenomenon is linked at the same time with the central phenomenon of detonator reading and audio-visual material, i.e., the rainbow and the visible spectrum of light. Some challenges and simple questions are launched such as: "Why do we see an apple red?", to speak of how the colors of the objects we see, is the part of the white light that bounces to our eyes, while the rest of the colors of the spectrum does not bounce, but is "absorbed" by the object in question.

The group of students use green and red cellophane filters to see how we perceive the colors of objects through these, which are noticed more or less and what this has to do with the order in which light is diffracted (red, orange, yellow, green, blue and violet). If they have doubts or do not remember what the order of the spectrum is like, they use a low-cost diffraction lens, which is shown in more detail in the analysis of results. Without mentioning diffraction as such, from the "behavior" of the colors in their view to using this variety of filters, students are asked to make a drawing-like design where they can place a hidden message, which is identifiable only from the red filter (cellophane).

Figure 5
Diffraction lenses similar to those used in the class

Source: adapted from Google (2024).

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 155-188.

Method of analysis

The analysis is qualitative since the interest lies in the particular cases of the conceptual construction of each student and the ability to translate it into a specific didactic material. The reference on the construction of conceptual knowledge and its evaluation process starts from the postulates of Ahumada (2005), whose approach is identified with social constructivism, since conceptual knowledge goes beyond the memorization of data or facts, and implies a deeper understanding of the key concepts of an area of knowledge and how these relate. This way of learning concepts allows those who learn to transfer what they have learned to new situations and problems, instead of repeating the information in a mechanical way, something that is more related to the definitions of an encyclopedic nature.

If thinking on such a conceptual construction approach, the evaluation should go in this same direction, far from traditional exams or even standardized tests. Why doing that? This type of testing, centered on memorization, tends to focus on the reproduction of procedures or repetition of data, without requiring that the learner demonstrate a deeper conceptual understanding.

Continuing with Ahumada to evaluate this type of knowledge, an "authentic evaluation" away from traditional exams is proposed, which focuses on more complex and meaningful tasks that reflect everyday situations. These tasks require that conceptual knowledge be applied in problem solving, decision-making, and that its transferability be demonstrated.

This type of evaluation involves some characteristics such as tasks that reflect real-world situations in which the learner applies knowledge in specific products or situations, focusing on the construction process and not only on the final result, and providing information to the learner about the progress and difficulties of the learner. On the other hand, the advantages of this type of evaluation are the promotion of deeper and more meaningful learning, allowing those who learn to demonstrate their (conceptual) understanding in contexts that are recognizable to them. In addition, beyond the above advantages, it also implies some challenges and limitations. The first concerns time and resources to design and grade these types of tasks. It is not that a process of this nature cannot be carried out in large groups, but during an entire course, certain topics should be selected. In the case that corresponds to this contribution, it was possible during an entire school year because it was a group of less than 20 people.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 155-188.

Another challenge is that this type of proposals can be labeled as too subjective, however, there are proposals for reliability as mentioned in the following section, but ultimately it remains based on the criterion of the professor, his own conceptual domain and the specific objective of each process, the central elements of methodological rigor. Finally, for students who are not accustomed to complex tasks of this type that involve their creativity, it is also suggested to do it gradually.

Instruments

In this type of intervention proposal, assessment tools focus on assessing skills and knowledge in real and contextualized situations, rather than relying (solely) on decontextualized standardized tests. The instruments are many and varied, ranging from rubrics to performance tests (Ahumada, 2005), but for the purposes of this contribution, emphasis will be placed on two: evidence portfolios and projects and presentations.

Portfolios are a somewhat popular tool for assessing progress and achievements. This (organized) collection of evidence can also be consulted by those who study to see their progress. Using the portfolio also promotes evaluating items that are difficult to measure in isolation or with standard tests such as critical thinking or communication. These elements are essential in this contribution because they are essential skills in teaching. Derived from this, reflection and self-evaluation can also be contemplated, since, by reviewing their own work and progress, they can identify strengths and areas for improvement, developing a greater awareness of their learning. Finally, the potential of the portfolio allows others interested in the learning process to become more actively involved, in this case, their peers. This may include reviewing with the rest of the group, and discussing their progress and achievements. They also favor a more complete and authentic image of performance due to the variety of works exhibited.

For its most effective implementation, it is suggested that the objectives be clear and specific. This includes defining the skills and knowledge being assessed. They should also be organized in a way that is relatively easy to follow up. This may include creating specific sections such as topics or time periods. If possible, feedback with the teacher should also be considered. It should be noted that, following online work during the 2019 pandemic, the standardization of educational platforms as a form of habitual work greatly facilitated the use of a portfolio, especially in the

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 155-188.

way it is structured and organized chronologically. In this case, the Google Classroom platform was used. That also facilitates individual feedback.

As for projects and presentations as an evaluation tool, these favor the creativity of those who learn, since there is some flexibility to incorporate, in this case, the concepts addressed with not only everyday situations, but of their particular interest. The evaluation criteria are very similar to those already mentioned in the portfolio, focused on decision-making, communication and critical thinking. For the purposes of the contribution, creativity and innovation were also essential, since we talk about the projects generated were requested with a didactic and replicable intention in the classrooms. A short project was considered for each of the seven thematic blocks; in this contribution the corresponding to the two selected blocks will be shown: movement and light.

Analysis and results

The data are presented in the same order of the analysis *corpus* mentioned in the previous section, starting with the block that refers to the movement (table 1). The selected works are an exercise in thoughtful questions about the film *Gravity* and a series of similar questions about the three video segments of the films *Antman*, *Captain America: Civil War* and *Avengers: Final Game*. Questions regarding the films were:

1. Three hits the film shows regarding Newton's laws.
2. Three errors or inconsistencies shown in the film regarding Newton's laws.

Table 1
Student responses*

Student 1
Analysis exercise, film *Gravity*
1. Three successes of Newton's laws in the film
We can see the law of inertia in every object in space, or the same protagonist who keeps moving when there is nothing to stop them, drifting.
The 3rd law of action-reaction can be seen when the protagonist uses the extinguisher to approach the station, the force that produces it drives her in the opposite direction.
The 4th law of gravitational force is seen in all objects that remain in orbit around the planet.

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2. Three errors or inconsistencies he shows regarding Newton's laws
When the protagonist is hooked from the foot to the base and holds her partner by a rope, it makes no sense that he is being pulled back and forth from nowhere.
Sudden movements outside the ship without more propulsion than the protagonist's force do not comply with Newton's 3rd law.
When there are collisions with the other ships, they only break, but many times they do not move as they should considering the force of the collisions.
Student 2
1. (Inertia) When the crew member goes astray, it is in constant motion, until the partner exerts a force to catch it. (Dynamics).
The difference between the station and the craft are different and the starting force and acceleration are exerted by the different masses. (Action reaction). The cosmic garbage when having movement collides with other objects and impacts so much that actions can be generated in the same direction or it can brake and go to opposite senses.
2. The tears that run down the scientist's face do not float.
When the escape pod was opened, the scientist inside had no reaction, though it was only in her imagination.
Upon landing, the scientist immediately exited the spacecraft without reaction in her body by the different gravitational forces.
Student 3
1. Three successes the film shows regarding Newton's laws
When the protagonist breaks off from a structure in space, she experiences a curved trajectory due to Earth's gravity. This is in line with the law of universal gravitation.
In several scenes, the characters experience the lack of resistance to movement in the vacuum of space, showing inertia in action; for example, when the doctor is in space, without moving or being subject to anything and her partner arrives for her, but she fails to stop before playing with her and that touch causes the doctor to move.
When characters use thrusters, or even in a scene, the extinguisher, they experience a reaction in the opposite direction, moving in the opposite direction; this is in accordance with the law of action-reaction.
2. Three errors or inconsistencies shown by the film regarding Newton's laws
In several scenes in the film, the main characters suddenly slow down, or completely stop their movement in space without the application of an external force; according to Newton's first law, a moving object will remain in motion unless an external force acts on it. Therefore, in the vacuum of space, where there is no significant friction, the characters should not stop so abruptly without the intervention of a force.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 155-188.

The film features rapid motions and orbit changes that are unrealistic; switching from one orbit to another would require a significant amount of energy and propulsion. (not equivalent to force on both sides, action or reaction).
At times, it shows an extreme velocity of approaching objects due to gravity, as if they were suddenly falling towards Earth. This type of representation goes against the principles of the Universal Gravitation Law
Student 4
1. Three successes the film shows regarding Newton's laws
Newton's first Law (Law of Inertia) as it is observed how astronauts and objects are kept at rest until something causes them to move.
Newton's Third Law (Action and Reaction) when astronauts use thrusters to move.
Newton's Fourth Law (Law of Gravitational Force) when astronauts are shot into space, they were attracted by the gravitational force of either the moon or the earth.
2. Three errors or inconsistencies shown by the film regarding Newton's laws
When the astronaut let go he was shot fast and should be slower by the law of gravitational force.
The speed of movement and efficiency of the thrusters is exaggerated.
The sound of explosions.
* The names of each student are omitted. The responses of four students are shown. Responses respect each student's writing style, including some writing and spelling failures to keep data in the way it was received.

At the screening of the film Gravity, the students were able to identify the following **successes** about Newton's Laws: The **first student** replied that the Law of Inertia "is observed in objects that are kept moving in space, including the protagonist, who continues to move without stopping when there is no force to stop her." In the same sense, he identified that the Law of Action-Reaction is illustrated "when the protagonist uses a fire extinguisher to approach the space station; the force exerted by the extinguisher drives it in the opposite direction." As a final success, he identified the Law of Gravitational Force "in objects that remain in orbit around the planet."

The **second student**, said that the Inertia Law "is observed when a crew member strays and continues in constant movement until a partner applies a force to catch her." He also noted that the Law of Dynamics "is reflected in the observed differences in force and acceleration between the station and the spacecraft due to their different masses." Finally, he linked the Law of Action-Reaction in "the cosmic garbage in movement,

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 155-188.

considering that when impacting other objects it generates reactions that can direct it in the same direction or make it change its meaning".

The **third student** stated that the Law of Universal Gravitation "is evidenced when the protagonist detaches from a structure and follows a curved path due to the gravity of the Earth." Regarding the Law of Inertia, he responds that it "is shown in scenes where the characters experience the lack of resistance in the vacuum of space; for example, when the doctor is not subject to anything and her partner arrives but cannot stop before pushing her, generating her movement." Additionally, he commented that the Action-Reaction Law is seen "when characters use thrusters or a fire extinguisher, observing how the force generates an opposite reaction that drives them in the opposite direction."

The **fourth student** selected in this block replied that the Law of Inertia "is observed in astronauts and objects that remain at rest until something external moves them." He also argued that the Action-Reaction Law "is reflected when astronauts use thrusters to move around." And finally, he commented that the Law of Gravitation "is perceived in astronauts who are attracted by the gravitational force of the Earth or the Moon."

As for the **errors** detected in the scenes in the aforementioned film, the students expressed the following: The **first student** argued that "in one scene the protagonist is hooked on the foot to a base and fastened to her partner with a noose, but that it makes no sense for her partner to be pulled into space inexplicably." In addition, he identified that "the abrupt movements of the characters outside the ship, without any additional propulsion, do not comply with the Action-Reaction Law." In conclusion, he says that "in collisions between spacecraft they only break, but they do not move as they should if the laws of the forces involved were correctly applied."

Meanwhile, the **second student**, said that "the tears that run through the face of the scientist do not float in space as they should." Plus. He identifies that "when opening the escape capsule, the scientist does not experience any reaction, which seems more an imaginary than a physical representation." He also criticized that "the protagonist lands and leaves the ship without showing physical effects on her body, contradicting the influence of different gravitational forces."

The **third student** argued that "in some scenes the characters slow down or suddenly stop in space without an external force applied, which contradicts the Law of Inertia." He also questioned the rapid orbit changes presented in the film, replying that "such maneuvers would require a great deal of energy and propulsion." In conclusion, he argued that "the extremely fast approximations of some objects towards the Earth do not respect the principles of the Law of Universal Gravitation."

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 155-188.

Finally, the **fourth student** said that "in a scene an astronaut is released and launched quickly, when in fact it should move more slowly due to the Law of Gravitational Force." He also stated that the film "exaggerates the speed of movements and the efficiency of the thrusters used." In the last error identified, he noted that "sounds of explosions are heard in space," which is inconsistent with vacuum physics.

The analysis of these responses, as mentioned, focuses on the understanding of concepts seen or analyzed at another time, the relationship between these, the transfer to other situations and critical thinking. From the induction on specific situations that the film shows, each student can vary their responses towards generalization or deduce how close each situation is to Newton's laws previously seen, since there is no specific one to reach, but the ability to identify concepts within scenes; in this sense, it is notorious how various situations are identified and all can have valid arguments.

Some answers give concrete concepts of movement or Newton's laws, such as the first one making explicit allusions to inertia, action-reaction or gravitational force, all correctly. While some responses are more in relation to small objects, such as extinguishers or the protagonists themselves, other responses are more in the sense of large objects, such as ships, space stations or planet Earth. Regarding the errors detected, the responses are even more varied.

They comment on exaggerations in parameters of speed, distances or the detail of objects such as hair and tears that seem not to respond to the three laws. There is also the failure to comply with other phenomena not necessarily linked to Newton's laws, such as sound in space, the skills that a person would have to navigate with a fire extinguisher in a vacuum or the immediate decompression problems shown in the protagonist when returning to Earth.

The responses with the superhero fragments followed this same pattern, although it was easier to find the faults, as they are very evident in terms of strength, speed and endurance of the characters. At least, in the case of the character Antman, elements such as the speed required to travel distances such as a simple bath in its reduced size as an ant, or the advantage that it would have over other characters also when traveling large distances in its giant size, were noticeable. To a lesser extent there were discussions about what would happen to the density of someone who does not change mass, but does change size.

As for the final project of this block, the group was asked to develop their corresponding teaching material to illustrate something concerning the laws of Newton's movement. For illustrative analysis purposes, four examples are also presented in Figure 6.

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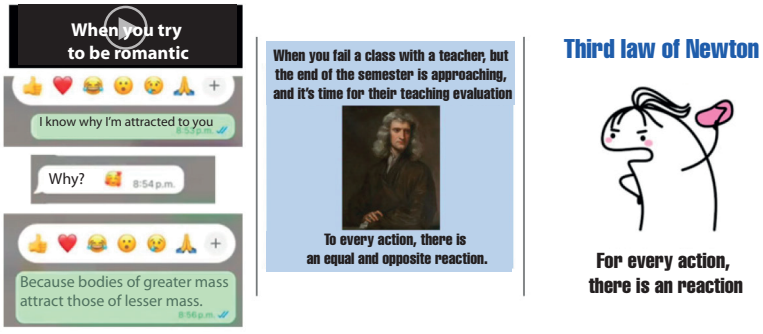
Figure 6
Extracts from the final projects of the block on movement



Regarding the second block (Table 2), some excerpts from the questions for discussion after Lewin's reading on the rainbow and how from this well-known phenomenon can be explained concepts that have to do with light, such as diffraction. This part of the portfolio was carried out after the disclosure reading and the refractive lens experiment mentioned in the previous section. The questions of this exercise were as follows:

1. How is the formation of the primary and secondary rainbow explained by the theory of refraction and reflection of light in water droplets? What are the differences between the two arches?
2. What is the relationship between rainbow formation and the lens diffraction experiment we did in class?
3. How could mathematics teachers integrate the teaching of concepts of optics and refraction, such as those shown in reading and in classroom experiments to enrich students' educational experience?

Table 2
Transcribed answers to portfolio light questions

Student 1
1. How is the formation of primary and secondary rainbows explained by the theory of refraction and reflection of light in water droplets? ¿What are the differences between the two arches?
Both rainbows are formed because the sunlight, when passing through the water droplets is refracted, and the white light is "separated" in the colors that compose it at different angles.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 155-188.

The difference between the two is that in the secondary rainbow the light passes through two reflections inside the water droplets and is therefore dimmer.
2. How did Young's double-slit experiment show that light is composed of waves rather than particles? How does this relate to the formation of supernumerary arcs in small raindrops?
Because if it always behaves as composed of particles at the time of having two slits some of the particles would pass through one and another for another, but to be waves patterns of interference are formed that pass when two waves interact; it relates to supernumerary arcs because in very small raindrops the waves of the different colors interfere more with those of the other colors, forming these dark or white areas that characterize this type of arcs.
3. What is the relationship between rainbow formation and the diffraction experiment with the lenses we did in class?
I consider that the mica of the lenses acts like a drop of water, making the light when entering them reflect and refract before reaching our gaze, and that is why we can observe that field of colors when using the lenses.
Student 2
1. How is the formation of primary and secondary rainbows explained by the theory of refraction and reflection of light in water droplets? ¿What are the differences between the two arches?
The primary and secondary rainbow formation are differentiated by the amount of bounce that light has within the water drop, since for the primary arc the light beam is reflected only once, and for the secondary arc, they are reflected 2 times before going out and refracting.
2. How did Young's double-slit experiment show that light is composed of waves rather than particles? ¿How does this relate to the formation of supernumerary arcs in small raindrops?
He proved this because he split a fine beam of sunlight into 2 and observed a pattern that could only be explained if the light was made up of waves, if it was made up of particles, each particle would pass through one or the other of the holes (not both) and look like 2 bright points instead of the pattern. This is related to the formation of supernumerary arcs in small droplets by the effects of interference (diffraction), since the interference of light waves is what produces the dark and bright fringes.
3. What is the relationship between rainbow formation and the lens diffraction experiment we did in class?
The relationship that exists between the formation of the rainbow and the experiment is that the light that we placed when passing through the lenses causes white light to divide between its different components of colors producing a pattern of colors with similar lengths

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 155-188.

At the end of a rainbow while the formation of the rainbow acts in the same way when sunlight passes through a drop of water, this is refracted thus causing white light to decompose into the already known colors.
Student 3
1. How is the formation of primary and secondary rainbows explained by the theory of refraction and reflection of light in water droplets? What are the differences between the two arches?
The primary and secondary rainbow formation are differentiated by the amount of bounce that light has within the water drop, since for the primary arc the light beam is reflected only once, and for the secondary arc, they are reflected 2 times before going out and refracting.
2. How did Young's double-slit experiment show that light is composed of waves rather than particles? How does this relate to the formation of supernumerary arcs in small raindrops?
He proved this because he split a fine beam of sunlight into 2 and observed a pattern that could only be explained if the light was made up of waves, if it was made up of particles, each particle would pass through one or the other of the holes (not both) and look like 2 bright points instead of the pattern. This is related to the formation of supernumerary arcs in small droplets by the effects of interference (diffraction), since the interference of light waves is what produces the dark and bright fringes.
3. What is the relationship between rainbow formation and the lens diffraction experiment we did in class?
In that both the drop and the lenses have no flat shape, but have curvatures that cause the light to change its direction many times and being so small and on several occasions is what allows the phenomenon of diffraction.
The answers, for the most part, allude to the implicit analogy between the concrete experiment—seeing white light from a common focus through diffraction lenses—and the phenomenon of rain described as an anecdote by Lewin. The vast majority identify the emission of white light from the Sun and white LED as a comparable phenomenon, as well as the function of raindrops with the diffraction grids that the lenses have. In some cases they go as far as to mention that the "non-flat" shape of both is the main cause for light to be decomposed into the visible spectrum.

As for the **first block of questions:** How do you explain the formation of the primary and secondary rainbow according to the theory of refraction and reflection of light in water droplets? What are the differences between the two arches?: The **first student** commented that the formation of the primary and secondary rainbows "is due to the refraction of sunlight as it crosses water droplets, separating into the colors that

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 155-188.

compose it." He commented that the difference between the two arches lies in the fact that "in the secondary rainbow the light experiences two reflections inside the drops, which makes it dimmer". The **second student** said that the formation of the primary and secondary rainbows "is explained by the number of reflections that light makes within a drop of water: in the primary arc, light is reflected only once, while in the secondary it is reflected twice before refracting and leaving." Finally, the **third student** explained that the primary and secondary rainbows are formed due "to the refraction of light in water droplets, differing in number: one for the primary and two for the secondary."

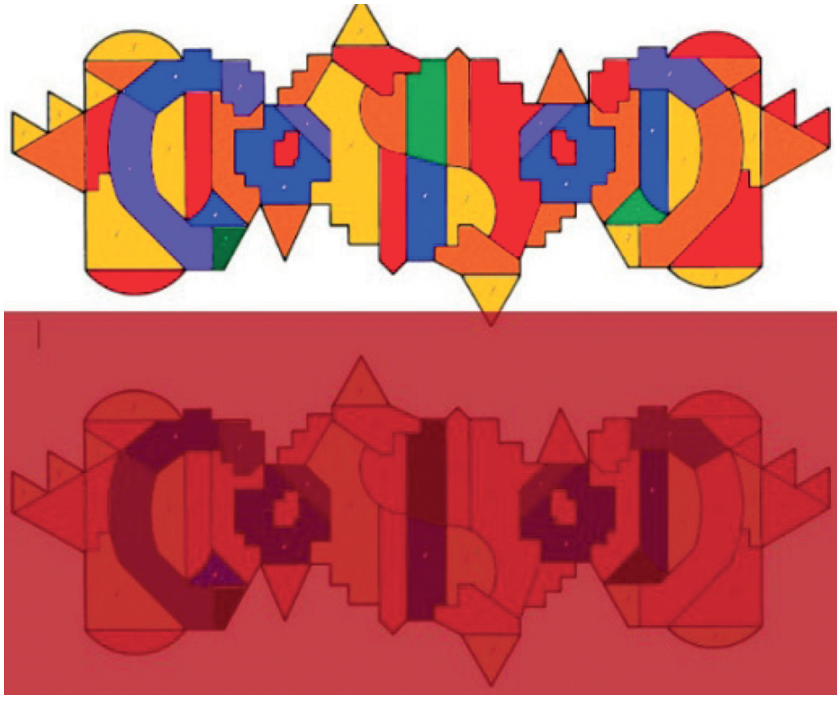
Regarding the **second block of questions:** How did Young's double-slit experiment prove that light is composed of waves rather than particles? How does this relate to the formation of supernumerary arcs in small raindrops? The **first student** pointed out that it was "shown that light is formed by waves and not by particles, since waves produce interference patterns when interacting", and related this phenomenon with supernumerary arcs, recalling that "in small raindrops light waves of different colors interfere more, generating dark or white areas characteristic of such arcs." The **second student** noted that the experiment demonstrated the wave-like nature of light by splitting a beam of light in two and observing interference patterns that would not occur if it were composed of particles. The relationship he made with supernumerary arcs was by arguing that the interference of light waves in small raindrops generates dark and bright stripes. The **third student** stated that the experiment proved that light behaves like a wave, in a very similar argument to the second student. Regarding the relationship with supernumerary arcs, he alluded to the fact that wave interference "in very small droplets produces those characteristic fringes".

In relation to the **third block of questions: What is the relationship between the formation of the rainbow and the diffraction experiment with lenses that we did in class? The first student** said that "the diffraction **experiment included "a mica that acts like a drop of water, refracting and reflecting light to produce a visible field of colors."** The **second student** pointed out that the relationship between rainbow formation and the lens experiment lies in the fact that "both phenomena involve the decomposition of white light into its colored components, either through water droplets or when passing through curved lenses," while the **third student** explained that "both water droplets and lenses have curvatures that cause light to change direction repeatedly, allowing to observe rainbow-like patterns of color."

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 155-188.

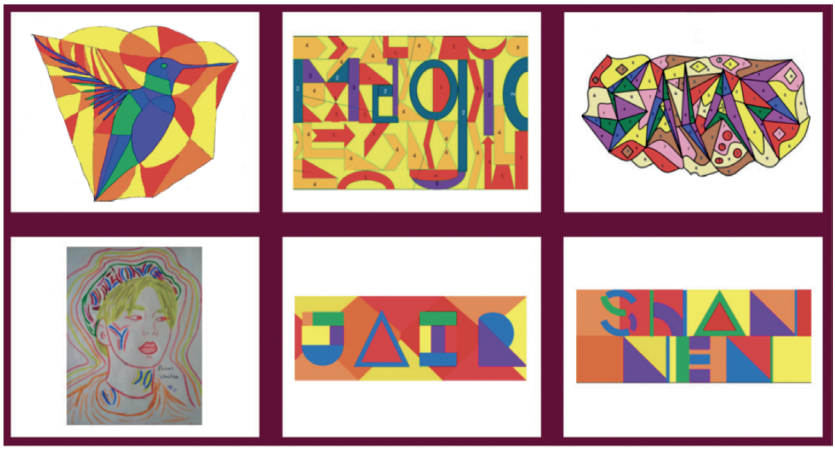
Moreover, the project of this block also referred to the visible luminous spectrum. After identifying that by diffraction the color pattern is always the same in order, it was corroborated that some colors called cold (green, blue and violet), are darkened when filtered by some color on the other side of the spectrum (red, orange or yellow). From detecting these patterns, it was generally asked that they use these features to design a hidden message, which was only discovered using a filter (red cellophane paper). This aspect requires the understanding of the filter with respect to the visible spectrum, but at the same time it gives enormous flexibility for creative thinking to develop. For example, two examples are presented in Figure 7, where it can be seen what an unfiltered and filtered message looks like; while Figure 8 shows some designs made by the group of students. The patterns are identifiable, however, if the reader has a red cellophane paper on hand, they can use it and the messages will be clearer.

Figure 7
Filter-free and filter design



Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 155-188.

Figure 8
Some group of designs



Results of the use of strategies

Taking up what was raised by Andrade *et al.* (2018), the student has historically had a receptive and passive role in learning scientific definitions and guaranteed formulas. More active participation of learning experiences places them in a meaningful learning process. The claim that science is a combination of imagination and logic may not be as common, but the assumptions and theories for imagining how the world works is something that requires as much creativity as the arts.

In this sense, the inductive strategies used in this research show that induction, sometimes in the form of experimentation or through the dissemination readings, is effective to promote the conceptual construction of physics topics among future teachers of the Bachelor of Science in Mathematics. Unlike more traditional approaches, focused on problem solving and memoristic learning of definitions, inductive strategies show that students can, in effect, start from particularities to come to the understanding of more general concepts.

The use of audiovisual materials and popular scientific readings as triggers for this induction, instead of more conventional textbooks, managed to encourage the group of students to reflect on the applications and context of physical concepts, instead of focusing solely on mathematical formalism. This allowed them to develop a more comprehensive un-

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derstanding of topics such as movement and light, transcending simple procedural mastery.

Several students made conclusions from linking the three aspects and not in linear order, but some gave meaning to the readings from a direct observation of the audiovisual material, or from experimentation. It also occurred in reverse, i.e., using the popularization readings to name the visual or experimental elements. Under this logic, it is possible to speak of an integration into a broader and even cumulative scheme, as mentioned by Dávila Newman (2006), from deductive reasoning, the above without having a specific chronological order for the use of the various materials.

Discussion

An important finding of this research was that the inductive approach favored students, who had a solid mathematical training but little prior exposure to physics, to build a deeper conceptual understanding of the topics addressed, especially in some evident processes of transfer to other situations. From their own observations and everyday experiences, they were able to establish significant links between physical concepts and their application or at least their presence in the real world.

This contrasts with the memoristic and decontextualized learning that often characterizes traditional teaching of experimental sciences, where students tend to master equations and procedures without coming to a full understanding of the underlying phenomena. The inductive approach implemented in this study allowed participants to develop a more integrated and meaningful view as far as physical concepts are concerned. Only two thematic blocks were shown in this article, but in the rest of the blocks it was similar.

The results of the evaluation carried out at the end of the course show that the students achieved an outstanding performance in the conceptual understanding of the topics addressed. Not only did they demonstrate mastery of definitions and formulas, but they were able to explain concepts, relate them to everyday situations and apply them in solving problems, some not necessarily numerical, but related to creativity. In addition, the final works of the students showed a capacity for reflection and analysis that goes beyond the mere reproduction of information. This suggests that the inductive approach allowed them to develop critical thinking and knowledge-building skills, rather than being limited to memorization (Ahumada, 2005).

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Regarding the contribution to the educational field, by integrating the use of scientific dissemination materials and experimental activities (Cuevas, 2020), this approach manages to transcend the traditional emphasis on the resolution of repetitive exercises and the memorization of formulas. Furthermore, the fact that this experience has been carried out in the context of the training of mathematics teachers opens the door to the implementation of these strategies at various educational levels, from basic to higher education. This has the potential to improve the teaching and learning of physics, while contributing to the scientific literacy of students.

The findings, up to this point, open a further possibility that the implementation of inductive didactic strategies, combined and supported by dissemination and experimental resources, can be a valuable tool to promote a deeper and more meaningful conceptual understanding of the experimental sciences. This approach, with potential for replicability, represents a relevant contribution to the field of science and mathematics education, with positive implications for the training of future teachers and the learning of students.

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Julio Cuevas Romo	As it is a single author, the total contribution corresponds to the same author. The content presented in the article is the sole responsibility of the author

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Julio Cuevas Romo, DECLARES that the elaboration of the article ***Conceptual construction in physics through inductive didactic methods,*** had the support of Artificial Intelligence (AI) on pages 14, 17, 18 to transcribe the evidence that was initially scanned On page 22, the AI was used as a support for style correction in bibliographic references according to the format requested by the Journal.

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The Eurotetic Approach in Ecocriticism

El enfoque erotético en ecocrítica

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Abstract

This article proposes an erotetic approach to define the ecocritical research program, analyzing the interrelationship between the conceptual frameworks of ecology and literary critical theory. A common structure based on problem agendas is suggested, enriching both scientific practice and teaching. The main objective is to demonstrate how the formulation of questions significantly contributes to the creation of open problem agendas that guide research, fostering the development of new hypotheses and promoting interdisciplinarity in research programs facing ecological challenges. The methodology includes a review of the theoretical structure of ecocriticism and how problem agendas provide methodological flexibility, allowing for the reformulation of questions as new data, technologies, and approaches emerge. The results highlight the importance of questioning in environmental sciences to redefine new research agendas, integrating conceptual frameworks not unified by a central theory. Ecocriticism is framed as a research program structured erotetically, much like ecology. The conclusions emphasize the interdependence between questions, problem agendas, and critical reflection on the scientific method, underscoring the creativity and utility of questioning and abductive hypotheses for a more suitable scientific practice, aligned with the urgency of the ecological crisis.

Keywords

Erotetic Organization, Problems Agenda, Ecocriticism, Interdisciplinarity, Ecological Crisis.

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Index h: 1

Resumen

Este artículo propone un enfoque erotético para definir el programa de investigación ecocrítico, analizando la interrelación entre los marcos conceptuales de la ecología y la teoría crítica literaria. Se sugiere una estructura común basada en agendas de problemas que enriquecen, tanto la práctica científica como la enseñanza. El objetivo principal es mostrar cómo la formulación de preguntas contribuye de manera significativa a la creación de agendas de problemas abiertos que guían la investigación, fomentando el desarrollo de nuevas hipótesis y promoviendo la interdisciplinariedad en los programas de investigación ante los desafíos ecológicos. La metodología incluye una revisión de la estructura teórica de la ecocrítica y de cómo las agendas de problemas aportan flexibilidad metodológica, permitiendo reformular preguntas a medida que surgen nuevos datos, tecnologías y enfoques. Los resultados destacan la importancia de los cuestionamientos en las ciencias ambientales para redefinir nuevas agendas de investigación, integrando marcos conceptuales no unificados por una teoría central. La ecocrítica se configura como un programa de investigación estructurado de manera erotética, al igual que la ecología. Las conclusiones subrayan la interdependencia entre preguntas, agendas de problemas y la reflexión crítica sobre el método científico, enfatizando en la creatividad y utilidad de los cuestionamientos e hipótesis retroductivas, para una práctica científica más adecuada y ajustada a la urgencia de la crisis ecológica.

Palabras clave

Organización erotética, agenda de problemas, ecocrítica, interdisciplinariedad, crisis ecológica.

Introduction

In a world marked by ecological devastation, it is essential to reconsider the issues and questions that guide our educational and research practices. Ecocriticism is a science that investigates the relationship between literature and the environment, however, it lacks a defined theoretical structure and a consensus scientific status. We propose to define ecocriticism as a research program structured erotetically, i.e., organized around a set of ecoevolutionary and sociocultural problems served by various conceptual frameworks. This erotetic approach, based on the conceptual structure of modern ecology, focuses on the formulation of questions and the elaboration of lists of problems, fundamental tools to improve the structure and utility of this discipline in constant dialog with research programs such as standard evolutionary theory or developmental biology (Kleiner, 1970, pp. 162-163; Love, 2014). By linking the agendas of ecological and environmental problems with different conceptual frameworks, we can foster a more dynamic scientific practice adapted to current needs. As Berkes (2004) says "the failure of exclusionary conservation approaches, which often ignored livelihoods and local knowledge, led to the emergence of 'participation' and 'community' as central concepts in conservation projects" (p. 621). This highlights the importance of involving local communities in the design of action, education and research agen-

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das, adapting these initiatives to the specific contexts and needs of each environment, which favors a more inclusive and effective science.

The main objective is to demonstrate how question agendas guide research in ecology and ecocriticism, facilitating the development of new hypotheses and promoting transdisciplinarity. As Julie T. Klein (2019) points out, "transdisciplinary and transnational rethinking of borders is broadening the scope of both interdisciplinarity and literary theory" (p. 1). The same author, elsewhere, points out that this level of integration in "transdisciplinary" education and research is associated with an integrative reorganization. In schools, it is reflected in models such as "curriculum integration", where disciplinary boundaries are blurred and connections amplified, compared to a kaleidoscope, where varied images produce a new design complexity (Klein, 1990, p. 13). Thus, integration becomes the central objective of education, not only as a tool, but as a principle that guides its practice. Similarly, in university research and programs, transdisciplinary approaches connect with integrative frameworks that transcend disciplinary boundaries, encompassing fields such as systems science, political science, feminism, cultural criticism, ecology, and sustainability. Here it is argued that ecocriticism should be organized as an erotetic research program, based on agendas of open questions that guide research, promote interdisciplinarity and allow to address more effectively complex ecological and socio-environmental problems.

The agendas also integrate marginal concepts that are often left out of traditional scientific approaches (Funtowicz and Ravetz, 1993). Erotetic structuring in research programs stimulates multidisciplinary collaboration to solve problems not addressed in standard models. It also highlights the teaching of question-asking and the development of local agendas to socialize environmental concerns (Holling, 2001, p. 392). This integration of transdisciplinary thinking offers more effective tools for tackling complex challenges in fields such as ecology, where the boundaries between the natural and the social become increasingly blurred.

The accelerated and irremediable damage facing the planet's biomes challenges the ability of our scientific and educational structures to adapt and respond effectively. Literary criticism does not have definite theoretical structure. Ecocriticism is understood as an interdisciplinary approach to a field populated with cultural and environmental phenomena urged in the literature. However, this approach has a double risk. On the one hand, lacking a recognizable scientific structure, it may lose contact with better structured research programs in natural sciences such as ecology, evolution or bioclimatology. On the other hand, when formulated with a literary

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 191-228.

and sociological foundation, ecocriticism could lose its interdisciplinary focus and develop as a subprogram of critical theory, of the theory of literature or of another theory on the basis of any environmentalism.

In both cases, ecocriticism could lose its theoretical potential and decay into intellectualized or stylistic descriptions of ideological discourses. This is a dilemma. Without the scientific structure offered by a research program, ecocritical theory would be at the mercy of some arbitrariness. Whereas, with a scientific structure tailored to the exact sciences research programs, ecocriticism would be doomed to remain outside the boundaries of scientific demarcation. It is necessary to adopt an intermediate position, by virtue of which ecocriticism consolidates its theoretical structure and at the same time, making use of it, can interact on an equal basis with any other science emphasizing its own progressive character.

In this context, philosophical reflection in environmental science should focus on concrete problems agreed from a common critical perspective, rather than addressing abstract questions derived from general theories or isolated frameworks of justification. Programs such as ecology or ecocriticism should not rely on centralized conceptual frameworks that do not always reflect the complexity of ecological problems. As Ostrom (2009) say "a common classification framework is necessary to facilitate multidisciplinary efforts towards a better understanding of complex ecological systems" (p. 420). This underscores the importance of developing more flexible and collaborative conceptual structures to address ecological challenges from a transdisciplinary perspective. Modern ecology has shown itself to be *quasi-independent* of the deep assumptions of evolutionary theory, coexisting without intention to disprove it. Similarly, ecocriticism can develop in a way that is not strictly dependent on literary theory, critical theory or ecological discourses, although collaborating and coexisting with them. This poses significant challenges: how to make science and teaching in fields such as ecology and ecocriticism more relevant and better adapted to their specific contexts? (Holling, 2001; Gotts, 2007) How to maintain the interdisciplinarity between ecology and ecocriticism without falling into superficial generalities? How can this theoretical field be structured so that ecocriticism functions as a research program in its own right?

We argue that problem agendas are essential to guide research and teaching in ecocriticism. By focusing on the formulation and adaptation of questions, we can improve the relevance and effectiveness of our scientific and educational practices (Nowotny *et al.*, 2001, p. 183). This erotetic approach facilitates the development of new hypotheses, promotes trans-

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 191-228.

disciplinarity and integrates marginal concepts (Pickett *et al.*, 2007, p. 11), in addition to using heuristic tools, such as representations and metaphors, that improve our understanding of reality at a decisive moment for the planet. By structuring an ecocritical research program erotetically, we can dispense with core theories and focus on organizing problems according to the contexts of discovery and participation, aligning them with environmental priorities.

The rationale for this study lies in the urgency of addressing ecological devastation effectively and adapted to local and current contexts. Erotetic logic can offer a useful tool to understand the structure and evolution of the sciences, clarifying which questions are valid under different paradigms and how they influence research (Kleiner, 1970, pp. 162-163). Question agendas can offer a flexible and dynamic framework needed to significantly improve understanding of socioecological dynamics (Folke *et al.*, 2005, p. 441), scientific practice in environmental sciences (Hourdequin, 2024), and ecocritical activity (Oppermann, 2006). The relevance of the erotetic approach (Werner, 2022) becomes evident when considering the need to integrate different disciplines and perspectives to address complex and specific problems (Rosenfield, 1992; Schrot *et al.*, 2020). In addition, the ability to adapt ecological and ecocritical research programs to new challenges and contexts is crucial in a changing world (Carpenter *et al.*, 2009). The suggested erotetic organization for ecology and ecocriticism allows focusing on the strategies of scientific discovery (Rivadulla, 2010), the practice and teaching of the sciences, maintaining an epistemic perspective attentive to the contexts that predispose to discovery (Reichenbach, 1938; Peirce, 1955) and also from a sociocultural perspective in local contexts that facilitate the expression of ecological concerns through the creative enunciation of emerging problems.

The methodology used in this article is a theoretical review of the conceptual frameworks and research programs that underpin ecological and ecocritical studies. This review examines how question agendas provide methodological flexibility and are adapted to various conceptual frameworks and research programs (Holland, 1995; Gotts, 2007). The inductive method is compared with deduction and abduction, emphasizing the relevance of the latter, together with "retroduction", in the formulation of questions and in the development of new hypotheses. In addition, it highlights its key role in the generation and sustaining of discovery contexts, which are fundamental to advance scientific knowledge (Rivadulla, 2010). Through a review of literary, cultural, environmental and ecologi-

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 191-228.

cal theories, we define the erotic structure of ecology and ecocriticism as research programs in constant dialog.

The article is structured in three parts. The first part explores the fundamental concepts, defines the organization of the sciences from an erotetic perspective and analyzes the importance of asking questions and how they contribute to the development of problem agendas. A connection is established between erotetic structuring and scientific research programs, highlighting the relationship between questions, problems, feedback and the context of discovery. In the second part, the erotetic approach is used to understand ecology and ecocriticism as theoretical structures, identifying common elements in their agendas. The importance of a current and specific scientific practice, which recognizes the dialectical way by which standard research programs become erotetic research programs, is underlined. It will address the idea that ecology and ecocriticism, lacking a central theory, integrate multiple conceptual frameworks and address a plurality of problematic aspects, which makes them a reference for ecosystem sciences, as well as for cultural and literary sciences. Finally, in the third part, the ecocritics as a research program is analyzed as a theoretical structure specifying the hard core, the protective area and the positive and negative heuristics, defining some conceptual frameworks and current problematic agendas in ecocritics.

Questions, problems and ecological agendas under construction

Questions, problems and problem agendas play a central role in the structure and evolution of scientific research. Philosophy of science suggests adopting an "erotetic organization" approach to emerging research programs, focusing on the formulation and resolution of interrelated questions, rather than focusing solely on the confirmation or refutation of theories (Kleiner, 1970; Brożek, 2015; Werner, 2022). The problematic agendas function at multiple levels in the hierarchy of objects of study, offering an organizational structure based on the nature of the problems and questions investigated, promoting methodological flexibility and transdisciplinarity.

Scientific questions seek knowledge about specific phenomena and can be empirical or theoretical (Love, 2014, p. 47). They are not isolated curiosities, but seek to deepen the understanding of complex natural or sociocultural systems. Formulating problem agendas around ecoevolutionary and sociocultural interactions is critical to developing strategies

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 191-228.

for ecosystem conservation and preservation. These agendas underpin the structure of the ecocritical research program, which provides hypotheses and guidelines for action on emerging issues. Questions about the phenology of a tree are not limited to its isolated flowering or fruiting, but relate this process to the phenology of the entire system, including the sociocultural subsystem.[1] Questions about the coexistence relationships in the biological community of the tree niche are explored, considering the organism as part of a community network. Some questions will concern symbiotic relationships, energy flows and biogeochemical cycles, or local aspects in a specific ecological and socio-environmental context. For example, what are the ecological actors involved in these phenological events? What is the relationship between the flowers and fruits of this tree and other organisms? How does deforestation and mining affect this biological community?

Some questions are resolved with basic or exploratory documentary research, while others address issues with no current resolution. Questions should avoid triviality and orbit around a coherent structure based on prior scientific knowledge. Problem agendas guide research within a specific field, helping to define priority topics and organize existing knowledge, facilitating the development of new theories and experiments. As Love (2014, p. 15) indicates, for the case of developmental biology as an erotetic research program, problem agendas act as units of scientific organization not as individual questions.

At the intersection of biological and political aspects, various ecoevolutionary and sociocultural issues for ecocriticism appear. An agenda issue may address the lack of knowledge about the symbiotic and ecoevolutionary relationships of a tree, or the need for governance and citizen participation to contain illegal exploitation of forest resources. The agenda will also reflect on the natural and anthropological history of the ecosystem and establish interdisciplinary contacts. In the face of the degradation of ecosystem processes, symbiotic and ecoevolutionary relationships will be addressed, extending the local agenda towards regional agendas.

In addition, the problem agenda will recognize the intrinsic value of flowering and fruiting processes as eco-evolutionary, ethical and aesthetic processes that enrich the ecosystem and promote the eco-physiological health of humans, animals and ecosystems. These cases are part of various conceptual frameworks, requiring a coherent research structure. Eco-evolutionary and eco-critical agendas are central, and other areas of study will share problems and work interconnected. Evolutionary biology will establish adaptive principles, bioclimatology will assess the

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 191-228.

impact of threatened species, while jurists, engineers and environmental educators will develop strategies that will cohere the community and demand political, economic and judicial measures. Artists and literati will also highlight the ethical and aesthetic value of the eco-evolutionary process in literature, art and tradition. Ecocriticism will warn of the danger of the disappearance of a plant, which drags processes and values destabilizing the socio-cultural structure of the ecosystem.

The fundamental characteristics of the erotetic organization are: heterogeneity, historical stability, connectivity, hierarchy and epistemological accessibility (Love, 2012, 2014; Nickles, 1981, p. 15; Bromberger, 1992, p. 20). Questions on a problem agenda include empirical, theoretical, and speculative questions that fluctuate between different levels of organization (heterogeneity). For example, what are the historical and socioeconomic factors that define the distribution and interaction between niches in an ecosystem?, and how do these factors affect different levels of the ecosystem such as biomes, communities, or populations?

The questions are interconnected in the agenda, structuring long discussions (historical stability) and connected transversely between different types of phenomena, producing a network of interrelated problems (connectivity). For example, what is the relationship between the loss of Andean glaciers and fluctuations in river flows?, and how do variations affect socioeconomic and cultural relationships in the context of popular celebrations?

Questions are organized with a dynamic subordination (hierarchy), allowing problems to be addressed at different levels of abstraction and temporality, providing a clear organizational framework for research and education (epistemological accessibility). For example, in a debate about environmental policies in the face of problems such as institutional corruption, questions about seed pollinators and dispersers are subordinated to conservation strategies and anti-corruption policies. In a context of institutional transparency with optimal governance and environmental protection, the phenological problem can be addressed from its aesthetic consequences in poetry and art.

Contexts of discovery and formulation of abductive hypotheses in the Anthropocene

Questions lie at the base of our knowledge, all discovery and utterance occur in response to some kind of question (Collingwood, 1940, p. 23). This erotetic priority, although manifest in scientific logic, does not play a

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 191-228.

fundamental role in standard research programs, where experimental corroboration or refutation is paramount. However, in emerging contexts, research programs must address eco-evolutionary and socio-cultural issues in a flexible manner, using multiple conceptual resources to clearly identify problems and establish urgent hypotheses.

In this sense, emotions play a crucial role in both research and educational processes. Desire and enthusiasm, key components of educational emotional architecture, are essential not only to initiate, but also to keep these processes active and effective (Pérez, 2024, p. 55). Enthusiasm not only protects the emotional health of researchers and teachers, but also stimulates discovery and promotes the creation of new questions, essential elements to face complex problems such as the climate crisis and ecological devastation. In this way, the emotional dimension not only complements scientific logic, but strengthens research in areas where creativity and question generation are as important as experimental validation.

The experimentation and formulation of alternative hypotheses consolidate the scientific structure, although with some delay and commitment to keep the theoretical core intact in the face of emerging problems. The devastation of ecosystems not only changes planetary climate physiology, but also impoverishes the environment biologically and aesthetically. This global change can be approached scientifically from local and immediate perspectives, without conflicting with traditional scientific structure. Problem agendas must assume the centrality of new programs with erotetic structure and pluralistic research approach to avoid a split between mature scientific theory and the necessary pragmatic flexibility.

The process of scientific inference offers logical methods of knowledge: deduction, induction, and abduction. These processes do not operate in isolation, and various models of interaction exist (Hanson, 1958). The hypothetical-deductive model describes the scientific method as a cyclic and recursive induction-deduction process, where hypotheses are formulated to be confirmed or refuted by experimentation (Popper, 1959; Hempel, 1965). This cycle of scientific knowledge is developed in three contexts: discovery, justification and experimentation (Reichenbach, 1938; Schickore & Steinle, 2006). The context of discovery, associated with inductive logic, focuses on the generation of new hypotheses and theories. Here, abductive reasoning is crucial, allowing the formation of explanatory hypotheses from surprising facts (Peirce, 1955; Rivadulla, 2010, p. 120). The erotetic structure facilitates the incorporation of facts that trigger abduction, driving the creation of hypothe-

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 191-228.

ses. The justification context evaluates these hypotheses by logical and empirical methods, using deduction to derive logical consequences and induction to experimentally test a theory (Rivadulla, 2010, p. 120). The context of experimentation applies scientific theories and laws to understand coherently observed phenomena (Franklin, 1986; Radder, 2003).

In research programs, abduction is critical. According to Peirce (1955, CP, 5.145), it is the only logical operation that introduces a new idea, differing from induction, which validates theories from experience (*cf*. Rivadulla, 2010, p. 121). Abduction is essential in the creative process of science, generating new hypotheses, while induction validates these hypotheses by collecting and analyzing empirical data. Abduction and induction are complementary in scientific advancement (Hanson, 1958). For example, in the face of an observable environmental fact, such as variations in the flowering of a plant and the absence of certain birds that eat its fruits, the hypothesis of the relationship between these phenomena could be offered. Regional observers could link this phenological abnormality to deforestation or watershed contamination, establishing an abductive hypothesis about the correlation between these events and the disappearance of bird or insect species. Literatures, sociologists, ethnobotanists and artists could establish abductive hypotheses correlating the phenological event with losses in oral tradition, changes in uses and customs, or social and demographic phenomena.

Adopting an erotetic perspective in environmental sciences allows strengthening research programs, addressing emerging, surprising or problematic aspects without modifying the core of legacy programs. Among the surprising aspects can be cited the observation of new modes of organism-environment coevolution in an ecological context sensitive to anthropogenic bioclimatic modification. Among the problematic aspects are the ecological concerns that arise from the interaction between human technique and natural habitats. Observers will provide comprehensive and detailed information on the natural event, as well as the selection of the best available inferences. Then, specialists will design methodologies, choose inductive methods and develop alternative hypotheses, on the significant contribution of multiple actors who formulate novel questions and hypotheses. The ecologist will establish controlled experiments and use systematic and statistical data to analyze factors related to the phenology of the plant. The ecocritic will assess the impact of the ecological phenomenon on biodiversity and its ethical and aesthetic consequences, using symbols and metaphors to express themes of loss, climate change and human responsibility. It will also develop surveys to

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 191-228.

assess the impact on the food chain and trophic niches, collecting literature and structuring narrative and poetic works on this interdependence and the fragility of ecosystems.

This frees researchers and educators in environmental sciences from the perception of epistemic subordination by not being at the center of great unifying theories. Instead, it is proposed to co-exist alternative research programs that interpret biological and cultural cases outside the standard program. This preference for keeping the core intact and orienting observations towards peripheral aspects allows for coexistence and dialog between different conceptual frameworks without renouncing their fundamental assumptions. In addition, it opens the possibility that conceptual frameworks that orbit each other are understood as effective theoretical structures. It is suggested that the implementation of this erotetic perspective in ecology and ecocriticism fosters a dynamic vision that does not conflict with the strengthening of progressive research programs. Without ignoring the relevance of the contexts of justification and experimentation, it focuses, interacting with them, on the formulation of questions and current problems, approaching them with creativity and adaptability by formulating hypotheses in a context of discovery. This proposal redefines research in ecological and ecocritical sciences, promoting an inclusive and flexible approach that recognizes the importance of progressive change of agendas, the coexistence of multiple conceptual frameworks and methodological pluralism (Moss & Haertel, 2016; Webber, 2020). By implementing these strategies, a more comprehensive understanding of eco-evolutionary and eco-social systems is promoted, while "erotetic enthusiasm" is promoted, enriching the emotional and intellectual dimension in the structure of research and educational dynamics in environmental sciences.

Erotetic structure of research programs

Research programs are scientific approaches that include coherent theories and methodologies to explain observable phenomena and predict new outcomes. These programs are structured around a "hard core" of fundamental assumptions that are not questioned by researchers within the program. Around this core, there are "protective belts" of auxiliary hypotheses that can be modified or replaced in response to new evidence without endangering the central core (Lakatos, 1978). According to Lakatos, research programs are distinguished by two types of heuristics: negative heuristics, which forbids scientists from questioning the hard

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 191-228.

core of the program, protecting it from being directly refuted, and positive heuristics, which guides researchers in essential directions to extend and develop the theory, guiding the modification of auxiliary hypotheses and the generation of new predictions.

From the erotetic perspective, research programs can be understood as agendas of problematic issues that contain a set of questions. These agendas presuppose theories and models distributed around some fundamental assumptions and a set of conceptual frameworks that develop and expand them. By collecting problematic issues and enunciating themselves in the form of open questions, the agendas do not operate within the research program under the logic of empirical refutation, but rather they complementary direct their attention to conceptual frameworks that can provide their models and metaphors to address emerging challenges.

The organization of interrelated questions offers advantages that extend, adapt and improve the structure of research programs (Love, 2014, p. 20). It allows the incorporation of new questions and problems in the protective belts, ensuring the stability and continuity of the hard core, while integrating new knowledge and conceptual frameworks (integration of questions). Research programs can address problems at different levels of abstraction and temporality, providing a necessary structure to evolve and adapt to new scientific contexts (organizational structure). The interdependence between questions, problems, agendas and erotetic organization is fundamental for the development of sciences as research programs that dialog with different conceptual frameworks and transdisciplinary approaches, such as ecoevolutionary and ecocritical research programs.

Ecology as a science without central theory

The erotetic approach allows ecology to be configured as an "eco-evolutionary research program", also known as "extended synthesis in evolution" (Pigliucci, 2009), "eco-evo-devo" (Gilbert *et al*., 2015) or "synecological representation of evolutionary theory" (Toro Rivadeneira, 2021). Although historically linked to the theory of adaptive evolution, ecology benefits from new theoretical frameworks that expand its explanatory and erotetic capabilities, allowing it to address urgent environmental problems without limiting itself to an exclusively adaptive view. Despite having a solid scientific structure, it cannot be equated to research programs with a central theory of high predictability, such as relativity or plate tectonics. Ernst Haeckel (1866) named ecology shortly after the publication

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 191-228.

of *The Origin of Species* (Darwin, 1859). In its early days, ecology was not subordinate to evolutionary theory, but over time it was absorbed by the principles of Darwinian evolutionism and its modern formulation (Darwin, 1859; Wright, 1931; Mayr, 1942; Dobzhansky, 1970).

The modern synthesis of evolution, formalized in terms of genes and populations, encompasses ecological, embryological and ethological phenomena (Mayr, 1982). However, this framework excludes principles that do not align with the adaptive assumptions of population genetics. Fields such as population dynamics, ecological succession and island biogeography present robust principles, but omit surprising or anomalous facts to maintain the predictive ability of the standard model of biological evolution (Hempel & Oppenheim, 1948, p. 138). However, ecological phenomena are not limited to those explained by adaptive evolution in the strict sense. The theory of adaptive evolution is not enough to explain "anomalous" ecoevolutionary processes, such as the ecoevolution of biological communities and their bioconstructed environments, the evolutiveness of biological processes, the design of biological cycles and the inheritance of biosemantic contents (Toro Rivadeneira, 2021). These problems require a complementary view of standard evolutionary theory, recognizing new conceptual frameworks and problem agendas. The new perspective does not reject the standard representation of evolution, but recognizes that its ontological and epistemological assumptions do not encompass the full complexity of many observed ecological phenomena.

The theory of niche construction, for example, expands the evolutionary view by considering factors beyond genetics, proposing that communities of organisms modify their niches, affecting their own evolution and that of other species, and allowing the ecological and constructive to be as relevant as the genetic and adaptive (Odling-Smee *et al.*, 2003). These modifications include the transmission of non-genetic inheritances, such as material and cultural inheritances, and symbiotic or holobiont genetic inheritance, where multiple species co-evolve (Gilbert *et al.*, 2012; Jablonka & Lamb, 2005).

Although frameworks such as niche construction, phenology or bioclimatology address important issues, their scientific status seems subordinate to the central theory of evolution by not being formalized in their terms, remaining as accessory or superfluous hypotheses. There are two ways to broaden the perspective: a supplementary vision and a complementary one. The first seeks a new extended synthesis integrating evolution, developmental biology, and community ecology. The second does not pursue a large central theory for evolution and ecology, but va-

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 191-228.

lues scientific knowledge from its pragmatic concretion, recognizing the importance of scientific questions, problems and values in research and teaching (Müller & Pigliucci, 2010).

The eco-evolutionary research program will orient its agenda towards the flowering or fruiting process including the perspective of conceptual frameworks such as:

- The ecology of communities (synecology).
- The theory of building niches.
- The holobiont and symbiogenetic theories.
- Phenology and bioclimatology.
- Philosophy of evolution and ecology (Odling-Smee *et al*., 2003; Wilson & Holldobler, 2005; Margulis & Fester, 1991; Kylafis & Loreau, 2008).

The ecoevolutionary perspective will resort to open problem agendas through different problematic approaches such as convergent evolution (McGhee, 2011), the ecological and embryological origin of evolutionary innovations (Love, 2003a), the genetic assimilation of cultural and ethological aspects (Badyaev, 2005; Staddon, 1981; Hunt & Gray, 2007), or the biosemantic approach (L'Hôte, 2010). These frameworks and approaches are quasi-independent of the standardized representation of evolutionary theory, which formalizes gene flow between populations by principles such as competitive exclusion from adaptive niches and allopatric speciation. The "legacy perspective" (Uller & Helanterä, 2019) restricts observation and hypothesis formulation according to the central assumptions and fundamental theories of evolutionary theory, while the new perspective shifts to novel conceptual frameworks and open question agendas.

Ecocritical theory as a research program without central theory

The ecocritical research program will approach these processes from the perspective of literary, cultural and environmental analysis, including conceptual frameworks such as: literary theory, linguistics, philosophy of language, philology or critical theory; as well as various theoretical approaches integrated with environmental perspectives and their ethical, aesthetic and political implications (Glotfelty & Fromm, 1996; Garrard, 2012; Heffes, 2022). The ecocritical perspective will turn to the agendas of open problems that are addressed from approaches such as post-colonialism (Vital & Erney, 2006; Huggan & Tiffin, 2007, 2015; Hartnett, 2021),

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 191-228.

ecofeminism (Gaard, 2010, 2017; Adams *et al*., 2010), postmodernism (Oppermann, 2006, 2012; Murphy, 1997), the studies of memory (Wardi, 201; Baker *et al*., 2023), deep ecology (Simonds, 2022), systems theories (Clarke, 2001), digital literature (Posthumus & Sinclair, 2014; Gould, 2017) and post-humanism (Oppermann, 2013; Feder, 2014; Iovino, 2016).

These frameworks and approaches contribute to partial theoretical-literary representations related to the complexity of aesthetic and ecological facts in the ecosystem within a general erotetic structure. By structuring ecocritics with an erotetic vision, the object of study is broadened and the understanding of the text and the literary phenomenon from an environmental and scientific perspective is enriched (Buell, 2005; Heise, 2008). This provides a multifaceted and comprehensive view of the literature, essential to addressing contemporary ecological challenges. Research programs in ecology and ecocriticism can act as central programs in the current ecological crisis, providing a multidisciplinary approach that coexists with other research programs. This coexistence allows interaction and adaptation to current challenges. Problem agenda structures scientific research, facilitating the evolution and adaptation of these programs. By integrating new questions and problems, it enables innovation while ensuring the stability and continuity of scientific knowledge, promoting relevant and applicable research into emerging problems, rather than focusing solely on the verification or refutation of the deeper assumptions of their theoretical foundations.

The absence of a unifying theory in ecocriticism and ecology could be seen as a sign of disciplinary immaturity. However, both disciplines have made significant progress in their respective fields. Ecocriticism has developed robust knowledge and methodologies to explore the interrelationships between literature, culture and the environment, while ecology has progressed in understanding essential ecological processes and created innovative theoretical and methodological frameworks. The idea that a mature discipline must be supported by a central theory is a philosophical prejudice deeply rooted in scientific tradition, but not necessarily applicable to all disciplines (Love, 2014). Both ecocriticism and ecology have been shown to be able to generate deep and applicable knowledge by investigating specific problems and particular contexts, without the need for a unifying central theory.

The lack of a central theory in disciplines such as ecology and ecocriticism must be accepted. These disciplines are organized around specific issues and emerging questions, allowing for greater adaptability and focus on specific issues. Even when applying theoretical knowledge

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 191-228.

from other disciplines, such as literary studies, philosophy, environmental sciences, chemistry, and physics, they do not organize research in the same way that a central theory would. Ecocriticism and ecology are disciplines informed by theories, but they are not directed by a single theory. This approach allows ecocritics and ecologists to be flexible and adaptive, responding to new data and emerging challenges. Flexibility and adaptability are some of the greatest strengths of ecocriticism and ecology. These disciplines stand out for their ability to adjust and respond to new data and challenges, allowing researchers to adapt their approaches and methodologies according to the needs of the problem in question. Rather than following a rigid core theory, both disciplines benefit from an approach that facilitates continuous exploration and discovery, adapting to changes in knowledge and technology.

Dialectics between eco-evo-critical research programs

Erotetic research programs have emerged in various disciplines of the natural, social and cognitive sciences. In historical biogeography (Craw & Weston, 1984), demoecology and historical ecology (Peters, 1988; Balée, 2006), as well as in the theory of non-equilibrium systems and dynamics (Zimmerer, 2000). In addition, highly specific research programs have been developed, such as nematology, parasitology, marine phytoplankton study and prion study (Schomaker & Been, 1998; Denegri, 2008; Nunes-Neto *et al*., 2009; Pidone, 2005).

In the cognitive sciences, erotetic research programs have also had a significant impact. Notable examples include the neuroconnectionist research program (Doerig *et al*., 2023) and the embodied cognition research program (Shapiro, 2007). Likewise, they have been implemented in studies on inter-organizational relations (Biermann, 2016), rural economy and land use (Lowe & Phillipson, 2006), and in approaches that integrate social policy with international political economy, providing a critical and holistic evaluation of contemporary social policies (Ferragina, 2024). They also address complex urban and planetary health issues (Black *et al*., 2018).

Erotetic research programs deserve recognition for their distinctive nature. Although they do not focus on core theories, they constitute theoretical fields composed of multiple peripheral conceptual frameworks, selecting the most favorable assumptions to address new problems. They are, therefore, useful to define their specificity against underestimated study objects and similar conceptual approaches applied in

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 191-228.

different disciplines (Nettle & Frankenhuis, 2020). Research programs are not restricted to a methodological monism or fundamental phenomena; instead, they include multiple methodologies and address emerging social phenomena in their specific contexts. This is not a history of isolated theories, but a history of research programs, i.e., of sets of related theories (Lakatos, 1978).

A theoretical possibility to understand erotetic research programs without falling into scientific relativism and retaining their explanatory value in scientific progress without resorting to the scientism of standardized perspectives is critical realism. Developed in the 1970s, critical realism is a philosophical perspective that focuses on a stratified, emergent, and transformational ontology (Bhaskar, 1978). According to this theory, reality is composed of different levels that interact with each other: the empirical domain (what can be observed and experienced), the current domain (the events and processes that occur regardless of whether they are observed), and the deep domain (the underlying structures and mechanisms that generate the observable events) (Fleetwood, 2014, p. 182). This approach allows for a comprehensive understanding of the social and natural phenomena, recognizing that our knowledge of the world is mediated by our social experiences and contexts, even though reality exists independently of our perception.

From the perspective of critical realism, scientific methodology involves protecting one or more "hard cores" of fundamental hypotheses while adjusting or making independent auxiliary hypotheses to confront falsifications and develop hypothetical formulations. This methodological strategy makes it possible to evaluate research programs not only for their ability to predict new phenomena and solve problems, but also for their ability to identify and structure new problems. In this way, the stratified and transformational ontology proposed by critical realism complements the methodological structure, allowing a dialectical relationship between progressive research programs and new erotetic research programs.

Scientific progress requires a critique that goes beyond superficial empirical observations, exploring and transforming the underlying structures that inform observable phenomena (p. 184). In this sense, the evaluation of research programs is based on their ability to generate new predictions and solve anomalies, as well as on their ability to structure organized agendas of emerging problems. This fosters a theoretical coexistence that allows the adjustment and refinement of scientific theories through the acceptance of new perspectives that arise in the face of emerging problems.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 191-228.

Critical realism provides a comprehensive approach that recognizes the complexity and depth of reality, complementing and enriching the methodology of research programs. Both approaches emphasize the importance of underlying structures and ongoing criticism, providing a sound theoretical framework for scientific research and the formulation of new hypotheses in the face of emerging problems. The characteristic nature of the questions that make up an agenda of problematic issues in ecology and ecocriticism constitutes the basis for their development as research programs and ensures their erotetic structures. There is a dialectical relationship between standard research programs and erotetically organized research programs.

The main distinction between a standard research program (A) and an erotetically structured one (B) lies in the fact that the limits of the former design the ontological and epistemological assumptions of the latter. Consider, for example, the standard evolutionary program. It has been said that a fundamental ontological and epistemological assumption in program (A) is that genes are the only units of inheritance subjected to adaptive natural selection. Its negative heuristics, i.e., the limits it imposes on the scientific community, forbids the development of hypotheses that question this assumption. If over time questions arise that cannot be resolved empirically within this framework, a complementary research program structured in an erotetic way, called the Eco-Evolutionary Research Program (B), could be established. This erotetic program would start from the restriction of the standard program and propose that, although genes are units in adaptive natural selection, they are not the only units of inheritance, as they interact with other physicochemical, ecological and cultural channels. The realistic vision coexists here with the constructivist vision because the research programs respond to different facets of reality according to certain purposes and under certain conditions.

The dialectic between (A) and (B) allows for their coexistence. (B) cannot empirically refute (A), nor (A) can underestimate the theoretical and pragmatic relevance of (B). Both programs are useful: (B) offers novel hypotheses and traverses unexplored paths to describe and explain unresolved phenomena, while (A) continues to accumulate robust evidence to explain more phenomena with fewer auxiliary hypotheses. This situation operates in our current science in an immense plurality of research programs around interdisciplinary question agendas. The agendas point to the relationship between pre-existing conceptual frameworks that attend from the periphery of a program (A) to the aspects of a stratified, emergent, and transformational ontology.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 191-228.

In the realm of literary science, critical theory and environmentalism can be considered sociocultural research programs type (A), while ecocriticism would be an erotetic program type (B). The limits of each type of program (A) generate problematic issues that shape the minimum assumptions necessary for the new erotetic research program. It is suggested that ecocritical theory, like ecoevolutionary theory, has been constituted by a synthesis of problematic agendas collected from traditional research programs, the limits of which become the foundations of a new erotetic program.

Advantages of the erotetic approach in ecology and ecocritics

Environmental sciences face complex challenges stemming from the Anthropocene, such as social inequality, governance, cultural change and ecological phenomena (Steffen *et al*., 2007). These problems require methodological plurality, flexible conceptual frameworks, and heuristic tools to address them. Hence, new approaches to scientific research have emerged, responding to the growing complexity and urgency of global problems. "Post-normal science" focuses on situations where facts are uncertain and decisions are urgent, promoting the participation of a wide range of actors beyond traditional experts (Funtowicz & Ravetz, 1993; Ravetz, 1999). "Mode 2 research" emphasizes transdisciplinary collaboration and the integration of non-academic knowledge to address specific and complex problems more effectively (Gibbons *et al*., 1994). "Iterative problem-driven adaptation" (IPDA) advocates an iterative process of adaptation and continuous learning to address complex challenges in a flexible and responsible manner (Andrews *et al*., 2013). "Transdisciplinary research" (TDR.) also promotes collaboration between disciplines and social actors, seeking to "co-create" relevant and applicable knowledge (Klein, 2006; Walter et *al., 2007; Carew & Wickson, 2010; Jahn et al*., 2012; Lang *et al*., 2012; Wolf *et al*., 2013). "Sustainability science" seeks to understand and manage the interaction between human and natural systems to promote long-term sustainable development (Kates *et al*., 2001; Clark & Dickson, 2003; Komiyama & Takeuchi, 2006; Brandt *et al., 2013; Kauffman & Arico, 2014; Heinrichs et al*., 2016; Roux *et al*., 2017).

On the other hand, the concept "panarchy" describes the interaction of social and ecological systems through hierarchies and adaptive cycles (Gunderson & Holling 2002; Allen *et al*., 2014). Panarchy allows

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 191-228.

healthy systems to experiment and innovate while protecting themselves from instabilities by communicating between stable levels and more dynamic levels. This concept facilitates the understanding of sustainability as the ability to create, test and maintain adaptability and opportunities (Holling, 2001). Current approaches to science find a marked correspondence with the very constitution of nature, which is organized into complex units of interaction, from microorganisms to the biosphere. This organization reflects a dynamic hierarchy, where levels of restructuring are not discrete but interconnected. Epistemic categories are relative, just as scientific categories are not guaranteed by a natural taxonomy.

The erotetic structure, based on investigative questions, is suitable for ecocriticism. This structure allows methodological flexibility, interdisciplinarity and innovation to respond to new environmental challenges. To face complex challenges such as climate change, it is necessary to adopt an "ecology of knowledge" that integrates different forms of knowledge and disciplines, allowing a transdisciplinary approach that encompasses all human dimensions (Collado Ruano, 2017, p. 76). This critical approach contrasts with hegemonic science, which has been functional to power structures and which, according to Arce Rojas (2020), continues to impose an "epistemic colonialism", ignoring marginalized voices and alternative forms of knowledge (p. 82). It is remarkable the importance of considering the unknown in the planning of environmental problems, fostering the diversity of models and building resilience to face future significant environmental impacts (Carpenter *et al*., 2009).

In ecology and ecocriticism, the context of discovery rather than justification suggests asking dialectical questions and responding with retrospective hypotheses. This distinction is crucial for ecocriticism, which depends on creativity in formulating initial hypotheses rather than empirical justification. These hypotheses catalyze future empirical and theoretical research in rigorous justification contexts, allowing new ideas and interdisciplinary approaches to be explored.

Heterogeneity, historical stability, connectivity, dynamic hierarchy (panarchy), and epistemological accessibility ensure that ecocriticism can address a wide range of problems, maintaining internal coherence and a clear focus. This structure allows ecocriticism not only to analyze existing literature, but also to influence literary and scientific production, as well as environmental policies, promoting greater awareness and ecological action.

In this context of epistemological evolution (Belcher & Hughes, 2021) the erotetic approach of the ecocritical research program synthesizes current positions in favor of flexible scientific structures, while atten-

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 191-228.

ding to the urgency of addressing environmental concerns from literary expression and socio-ecoevolutionary research. Erotetic logic is used to clarify which issues are valid under different paradigms and how they influence research. Question agendas provide a flexible and dynamic framework needed to significantly improve understanding of socio-ecological dynamics, scientific practice in environmental sciences, and eco-critical activity, integrating different disciplines and perspectives to address complex and specific problems. The ability to adapt research programs to new challenges and contexts is crucial in a changing world.

The erotetic organization suggests strategies of scientific discovery, practice and teaching of the ecosocial sciences, maintaining an epistemic and sociocultural perspective attentive to local contexts that facilitate the expression of ecological concerns through the creative enunciation of emerging problems. Understanding, practicing and teaching ecology and ecocriticism as erotetic structures will allow researchers and educators to adapt to new contexts and challenges, facilitating methodological flexibility, interdisciplinarity, adaptability and innovation.

Erotetic perspective is necessary because neither ecology possesses a central theory, nor ecocriticism can be considered a theory in the strict sense of scientific logic. If assuming the relevance of thinking ecocritically about the ecology and the symmetric consequence of this approach (thinking ecologically about ecocriticism), then there are three possible paths:

- Give up a scientific structure for these disciplines.
- Subsume them in the hypothesis belts ancillary to other research programs.
- Structure them erotetically so that they can be constituted as research programs in their own right.

We assume the third way, in both sciences the erotetic perspective is extremely useful, avoiding that the complex and multidimensional ecological issues are reduced to specific instances of a genetic dynamic between populations (way 2) or that the ecocriticism is interpreted from a positivist perspective as a loose collection of literary or poetic speculations without basis in reality or problem-solving capacity (way 1). From this suggested perspective, ecology and ecocriticism can be experienced as eco-evolutionary and socio-cultural research programs that interact and enrich each other without losing their identity. The intersections between the two fields allow for a more comprehensive and multifaceted understanding of environmental problems.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 191-228.

We do not accept this quality of the ecocritical research program by renouncing any other theoretical qualification. In the same way that ecology and developmental biology are progressive sciences that accumulate observations and experimental evidence, ecocriticism advances by constructing conceptualization and dialog with scientific evidence. For example, ecocriticism, by incorporating evolutionary theory, can debunk the distortions of social Darwinism (Love, 2003b) and, by adopting the perspective of niche building and synecology, can draw attention to ecological ideologizations, demagogy, greenwashing, or pseudoecological literature. On the other hand, from a phenological and bioclimatic perspective, it can inspire essayists, literati, and artists to objectify their aesthetic experiences through narratives and poetics that find their historical foundation in cultural references.

Biologically informed ecological criticism is crucial to address contemporary ecological issues, as understanding the materiality of the natural world and its relationship to human cultures can challenge anthropocentric representations and promote a more integrated view of nature and culture (Feder, 2014, p. 78). For ecocritics to be a progressive research program, it must strengthen its interdisciplinarity with knowledge of the natural sciences (Buell, 2005; Heise, 2008), particularly of evolutionary biology and community ecology in order to understand with physiological rigor the relationship between human beings and nature. This vision is relevant not only to improve the conceptual spectrum of both areas of environmental thinking, but to continually review their assumptions, concerns and representations. For ecology to be a progressive research agenda, it must also draw on knowledge of the social sciences and humanities. Particularly literature and environmental ethics. This approach offers an expanded view of how organisms and their environments coevolve through complex and coordinated processes, eliminating the anthropocentric perspective and expressing in their problematic agendas a critical "ecoevocentric"[2] perspective of global processes.

Erotetic organization of the ecocritical research program

Ecocriticism, as an emerging field of study examining the relationship between literature and the environment, can be effectively conceptualized as a research program in the strict sense, following Imre Lakatos' methodology. Lakatos, in his works *Proofs and Refutations* (1976) and *The Methodology of Scientific Research Programs* (1978), proposes a structure for research programs that is divided into hard core, protective belt, po-

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 191-228.

sitive and negative heuristics. This structure provides an organized and coherent way to address ecocriticism, ensuring its sustained development and its ability to generate new knowledge.

The hard core of a research program, according to Lakatos (1978, p. 4), is the series of fundamental hypotheses that cannot be abandoned without discarding the entire program. In the context of ecocriticism, this hard core is composed of fundamental epistemological and ontological assumptions. These include the interconnection between culture, literature and the environment, the importance of literary representations, the interdisciplinary approach, ecological ethics and climate change. These premises form the unshakable foundation on which the entire ecocritical program is built. For example, the interconnection between literature and the environment is crucial because it allows to analyze how literary texts reflect and shape cultural perceptions of the natural environment (Glotfelty & Fromm, 1996, p. XVIII). Ecological ethics drives the study of how literature can foster an ecological awareness and a responsibility towards environmental conservation (Buell, 2005, p. 2). Interdisciplinarity with the human sciences and ecology extends the scope of ecocritical analysis, allowing an enriching dialog between disciplines that have traditionally been seen as separate. It is notable that due to its erotetic constitution, the hard core of the ecocritical program does not have theories but rules of the game that consist in maintaining the problematic issues of multiple agendas by structuring the program from an interdisciplinary perspective.

The protective belt, according to Lakatos, consists of a set of auxiliary hypotheses that protect the hard core by absorbing anomalies and allowing adjustments without compromising fundamental premises (Lakatos, 1978, p. 48). In ecocriticism, these auxiliary hypotheses include literary genres such as scientific fiction, nature poetry, travel narrative, children's literature, and magical realism. These genres offer different perspectives and approaches to explore the relationship between literature and the environment. Furthermore, historical and cultural contexts, such as the Industrial Revolution, colonialism and postcolonialism, modernity and postmodernity, indigenous cultures and social movements, enrich ecocriticism by providing specific historical and social frameworks for analysis (Heise, 2008, p. 5). Artistic interactions, such as film adaptations, visual arts, theater and performance, music, and art installations, further expand the scope of ecocritical analysis. Ecological movements, such as environmentalism, deep environmentalism, climate justice, sustainability and community resilience, and digital technologies and media, such as social networks, blogs, websites, digital literature projects, video games,

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 191-228.

and virtual and augmented reality, provide new tools and approaches for eco-critical study (Garrard, 2012). These elements allow a continuous adaptation of the program as new developments and challenges arise in the environmental field.

Positive and negative heuristics are methodological strategies that guide the development and protection of the research program. Positive heuristics in ecocriticism include strategies that foster new interpretations, questions, interdisciplinary advances, sustainability and awareness, and methodological innovation (Lakatos, 1978, p. 50). These strategies allow the ecocritical program to evolve and adapt, continuously generating new hypotheses and theories that enrich the field. For example, methodological innovation may include the use of new digital technologies to analyze literary texts or the incorporation of climate justice perspectives into literary analysis (Haraway, 2016, p. 31). Sustainability and awareness promote the idea that literature not only reflects but can also influence environmental action and social change (Buell, 2005, p. 7).

Negative heuristics, on the other hand, are strategies that protect the hard core of the program, prohibiting changes that could compromise its stability and coherence. In ecocriticism, these include protecting the interconnection between literature and the environment, the importance of literary representations, maintaining the interdisciplinary approach, conserving ecological ethics, and maintaining the relevance of climate change as a central theme (Lakatos, 1978, p. 51). These strategies ensure that the program maintains its integrity and focus, avoiding deviations that could dilute its fundamental purpose. The erotetic structure, which organizes knowledge around investigative questions, is particularly suitable for ecocriticism. The integration of questions and the organizational structure based on inquiry allow the field to remain dynamic and relevant. Methodological flexibility, interdisciplinarity and adaptation and innovation ensure that the program can respond to new challenges and developments in the environmental field.

The erotetic structure of ecocritical research programs emphasizes the plurality and diversity of approaches within the field. Each discipline, from literature and philosophy to evolutionary biology and economics, provides specific conceptual frameworks and research questions that enrich ecocritical analysis. Fields of literature such as literary theory, linguistics, and philology explore how literary narratives influence public perception of climate change, the role of linguistic discourses in constructing environmental identity, and the evolution of descriptions of na-

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 191-228.

ture in literature (Johns-Putra, 2019; Fill, 2018; Stibbe, 2015; Glotfelty & Fromm, 1996; Buell, 2005; Heise, 2008).

Philosophical domains such as philosophy of language, environmental ethics and environmental aesthetics investigate how ecological concepts affect our philosophical constructions of language, ethical principles to guide environmental policies, and the influence of aesthetic perceptions of natural landscapes on conservation policies (Morton, 2007; Alaimo, 2010; Plumwood, 2002; Attfield, 2014; Gardiner, 2011; Jamieson, 2014; Brady, 2018; Berleant, 2012; Carlson, 2009).

Areas of philosophy of science, such as ontology, epistemology, sociology of science, and philosophy of technology address questions about the emerging new ontological realities of the ecological crisis, the construction of ecological knowledge in modern science, and the role of technology in climate change mitigation and adaptation (Bennett, 2010; Braidotti, 2013; Morton, 2016; Haraway, 2013; Latour, 1999; Harding, 1991; Yearley, 1996; Jasanoff, 2012; Wynne, 1996; Schneider 2014; Klein 2015; Lovins 2019).

Sociology and anthropology with their set of theories of culture examine how cultural theories can mobilize collective action against climate change and how critical theory can dismantle power structures that perpetuate environmental degradation (Norgaard, 2011; Manzo, 2010; Pellow, 2017; Pulido, 2018; Mohai *et al*., 2009). Political theory and economic theory address governance models to address global ecological challenges and how economic theories can incorporate sustainability principles to foster a green economy (Dryzek, 2013; Ostrom, 2010; Paavola, 2005; Jacobs, 2013; Pearce *et al*., 2019; Daly, 1996). Likewise, economics with its approach to urban planning theory examines urban approaches that can mitigate the impacts of climate change in cities, exploring how urban planning can be adapted to improve climate resilience (Bulkeley, 2013; Calthorpe, 2010).

Conclusions

An erotetic approach has been proposed to structure ecocriticism, focusing on the formulation of questions and the elaboration of problematic agendas. The main findings and results of the research can be summarized as follows:

Research shows that the interdependence between questions and problem agendas is crucial for the flexibility and methodological adap-

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 191-228.

tability of ecocriticism. This effectively addresses the complexity of contemporary ecological problems. The erotetic structure facilitates the continuous updating of hypotheses and problems, incorporating new data and technologies. This approach is essential to maintain the relevance of scientific and educational practices in an ever-changing environment. The integration of concepts and methodologies from different disciplines, such as biology, philosophy and literature, enriches the ecocritical analysis and allows to address ecological problems from an integral perspective. In addition, the use of retrospective questions and hypotheses promotes creativity in scientific practice, facilitating the generation of new ideas and conceptual frameworks that are vital for the evolution and adaptation of research programs.

Ecocriticism, lacking a unifying central theory, is organized around specific problems and emerging issues. This feature avoids rigidity and facilitates continuous exploration and discovery of new perspectives and solutions. It emphasizes the need to teach the formulation of questions and the development of problematic agendas in scientific and literary education. This prepares researchers to effectively address emerging ecological problems and improves the structure and usefulness of ecocriticism. The research highlights the deep relationship between the ecocritical program and the ecoevolutionary program, considering them research paradigms with an erotetic structure. This dialectical relationship facilitates the development of new hypotheses and the adaptation of conceptual frameworks to current needs, highlighting the importance of interdisciplinarity in scientific research.

The results suggest that the erotetic approach can be a powerful tool to improve flexibility, adaptability and interdisciplinarity in ecocritical and ecoevolutionary research. This has important implications for scientific and educational practice, as it allows for a better response to contemporary ecological challenges. However, a potential limitation of this study is that, although the usefulness of the erotetic approach has been demonstrated, its practical implementation may require a significant change in traditional research and teaching methodologies. In addition, more empirical research is needed to validate and refine this approach. Future research could explore the practical implementation of the erotetic approach in various educational and scientific contexts. In addition, comparative studies could be developed to evaluate the effectiveness of this approach in relation to other methodological models. In short, the erotetic approach proposed in this article provides a robust and flexible structure for ecocriticism, integrating various disciplines and promoting

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 191-228.

methodological innovation. This approach is crucial to effectively address the complexity of ecological and social problems in the context of the Anthropocene, facilitating a more dynamic scientific and educational practice adapted to current needs.

Notes

1 A current problem arising from anthropic ecosystem degradation is seasonal anomalous variations. This example will focus on the phenology of a plant species and its relationship to the ecosystem and sociocultural processes of the habitat. By developing questions about this case, it will be illustrated how a specific process with ecological, evolutionary, aesthetic and sociocultural implications generates a series of questions and problematic issues. These issues are included in two complementary research programs: the ecological and the ecocritical.

2 There is no shortage of terms coined to overcome anthropocentric perspectives. Examples include "biocentrism" (Naess, 1973), "ecocentrism" (Leopold, 1949; Callicott, 1989), and "evocentrism" (Sarrazin & Lecomte, 2016). Nevertheless, I consider it useful to bring a new perspective, if only to enrich this conceptual and semantic field. In it, the fundamental aspect of ecological and ecocritical studies is both the scientific understanding and the aesthetic satisfaction that emanates from the ecoevolutionary processes, which are defined throughout this article under the term "ecoevocentrism" (Pagano, 2013, p. 25).

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Critical Perspective of Educational Innovation from Active Learning Methodologies

Perspectiva crítica de la innovación educativa desde las metodologías activas de aprendizaje

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Index h: 4

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Index h: 6

Abstract

The complexity of the challenges posed by the 21st Century calls for innovation, especially in the field of education, due to its presence, relevance and potential for the generation of solutions, forms of action and education that can be assumed by citizens, mainly those who are immersed in their educational process. For this reason, the aim of this work is to propose active methodologies as suitable means for implementing educational innovation centered on social processes, which place people at the center of the phenomenon, as beings in formation and, likewise, as creators and maintainers of innovations that promote well-being. Initially, it outlines the difficulties of the pedagogical renewal effort, in some of its fundamental texts and moments, to respond to the challenges and threats faced by contemporary societies, discussing some relevant notions of theory and Philosophy of Education. This contribution then attempts to add to the ongoing reflections on the Philosophy of Innovation, as a discipline in germ, which must in turn be linked to a proposal for a Philosophy of Educational Innovation. The aim is then to problematize, under these theoretical premises, pedagogical creativity and action programs linked to the tradition of activism and the recent proposals of Active Learning Methodologies, through the contribution of the social approach to educational innovation.

Keywords

Educational Innovation, Philosophy of Innovation, Activism, Active Methodologies, Educational, Paradigm.

Resumen

La complejidad de los desafíos que plantea el siglo XXI interpela a la innovación, especialmente en el ámbito pedagógico, por su presencia, relevancia y potencialidad para la generación de soluciones, formas de acción y formación que sean asumibles por la ciudadanía, principalmente por quienes están inmersos en el proceso educativo. Por ello, este trabajo tiene la finalidad de proponer las metodologías activas como medios idóneos para implementar la innovación educativa centrada en los procesos sociales, que ponga a las personas al centro del fenómeno, como seres en formación y, al mismo tiempo, como creadores y sustentadores de innovaciones promotoras de bienestar. Inicialmente, se esbozan las dificultades del esfuerzo de renovación pedagógica, en algunos de sus textos y momentos fundamentales, para responder a los retos y amenazas que enfrentan las sociedades contemporáneas, discutiéndose algunas nociones relevantes de teoría y filosofía de la educación. Seguidamente, esta aportación trata de sumarse a las reflexiones en curso sobre filosofía de la innovación, como disciplina en germen, que debe a su vez vincularse con una propuesta para una filosofía de la innovación educativa. Se pretende, a continuación, problematizar, bajo estas premisas teóricas, la creatividad pedagógica y los programas de acción vinculados a la tradición del activismo y a las recientes propuestas de las metodologías activas de aprendizaje, a través de la aportación del enfoque social de la innovación educativa.

Palabras clave

Innovación educativa, filosofía de la innovación, activismo, metodologías activas, paradigma, educativo.

Introduction

This research tries to critically explore various concepts and proposals related to relevant aspects of the innovative commitment of our societies, confronting them with the practices and learning models in educational environments. Thus, it aims to enrich the reflection in the field of

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innovation studies, especially as regards the theory and methodology in education, with the ultimate purpose of innovative educational processes to promote and maintain the social transformation necessary to respond to the enormous challenges of the 21st century. The central problem that inspires and mobilizes this and other research and practices is, therefore, to try to test responses from educational reform to the problems and threats that besiege the balances of coexistence in our complex and pluralistic societies: protection of human rights, achievement and maintenance of alliances for world peace, promotion of human well-being and the health of all people, reduction of environmental impact, gender equity, reduction of inequalities, among many others (UN, s. f.).

Hence, this work defends the fundamental idea that an educational reform that seeks to rise to these challenges must critically review its history, conceptual bases and methods, and evaluate the reasons for failures or insufficient results obtained throughout an already long tradition of designing educational change. Likewise, the importance of this proposal derives from the need to orient this educational change towards new models, methodologies and didactic endeavors that try to grant validity from theoretical foundations that are the result of a critical work of a pedagogical-philosophical type. It is worth noting that the proposal presented here is based on the fact that innovation appears as a central notion of a multitude of planning strategies, both public and private, concerning a wide range of productive and socio-cultural sectors. In fact, educational innovation is a dominant topic in the design of educational policies and projects and strategies to improve teaching, and for this reason this concept should be elucidated to question the relevance of eminently techno-scientific and market-oriented budgets, and direct attention to renewed social paradigms.

The research that supports this document is based on a comprehensive documentary review, which has included books, scientific articles and other reference sources framed in an extensive period of time, in order to have a complete vision on the concept of innovation, its application, scope and limitations in the educational field.

Methodologically, the analysis of the texts has been accompanied by the discussion of their theses among members of the research team and other professionals of teaching practice and pedagogical reflection. Likewise, these works are framed within the framework of educational innovation projects developed in the institutions involved, throughout whose execution, during the last years, the proposals have been partially implemented in innovative educational environments,

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 229-255.

with promising results and with relevant observations for the design of improvement proposals.

The article is structured in four main sections: "Education and social change", in which the current and relevance of the topics addressed is demonstrated, through the analysis of the evolution of education over time, especially its development after the Second World War, evidencing the immobility of the system despite the great political, social and environmental transformations around it. "Hegemonic paradigm of innovation (educational)" raises the way in which innovation has been conceived, inside and outside the educational field, making its gradual appropriation by scientific-technical discourses and market efficiency notorious, generating the loss of meaning in relation to the satisfaction of human needs, with the consequent opacity of its theoretical and methodological consistency. This element of theoretical and conceptual clarification is relevant, since it is proposed for the correct pedagogical and ethical characterization of transformative practices, especially considering that educational innovation is one of the central imperatives of educational policies today. Faced with the problems framed in the first two, it presents "Towards a new social paradigm of educational innovation", where the theoretical and methodological bases can meet the need for social transformation with a broad human sense in the personal and collective. Finally, "University and activism in higher education: factors for innovation" refers to the possibilities of implementing the methodologies mentioned in the previous section, including examples of their implementation in higher educational environments from different parts of the world, in which they have demonstrated their transformative potential.

Education and social change

The following statement can be read on the website of the United Nations Development Program (UNDP, s.f.):

> 20th century institutions will not be able to solve 21st century problems. The gap between the structural, interrelated, and increasingly complex and unpredictable challenges we are facing and the way we plan government and development issues is growing. The climate emergency, lack of trust in institutions, and growing inequality, particularly among women, make it clear that progress toward new ways of understanding and action is needed. *And yet, we continue to apply the same old methods* (emphasis on the original).

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 229-255.

The gaps referred to in this text seem to show an inability or delay of the institutions formed and stabilized during Modernity to face with solvency the increasingly complex and structurally interrelated challenges of Modernity as a threat to the social and political balances of our societies, and to the very possibility of survival of life on the planet. The application of the same methods as always does not account for problems whose complexity overflows, both the technical coverage that a certain current paradigm puts at the service of problem solving and the criteria to legitimize the type of planning that operationalizes the integrative sequences of activities that are designed for the intervention in the real. Perhaps, as the text also suggests, this inability is due to an essential lack of understanding, which correctly substantiates and justifies the strategies of action that seek to have a corrective or transformative impact on reality.

Education is one of those fundamental institutions whose reform is key to building social improvement and facing these structural challenges with certain guarantees, it is part of the discourses and what of can be understood as a standardized notion of what it means to educate or at least "institutionalized education". The correspondence between progress and/or sociocultural development, on the one hand, and education on the other, is part of the pedagogical concerns of the Enlightenment and, especially, after World War II. This new post-war discourse of progress and well-being (Cornago Prieto, 1998; Parpart & Veltmeyer, 2011; de Rivero, 2014) made formal education the most relevant aspect to trigger or reinforce processes of economic and cultural modernization, both in industrial societies and in developing regions. Since then, most theories, policies, and projects aimed at discerning, expanding, and systematizing the coverage and quality of formal education "have regarded education as a central force for sociocultural development and have seen formal schooling as one of the agents, if not the principal, of desirable social change" (Hawkins, 2007, p. 147). The democratization and mass education, also at the higher level, was precisely one of the objectives and consequences of the developmentalist policies aimed at the creation and support of formal school systems and study aids, with the aim, among others, of contributing to the creation of the necessary workforce to the modernizing project of nations (Pineau, 2001).

This evolution has led to a "priority and generalized presence of the educational in our society" (Casado, 1991, p. 27). Casado, based on data from UNESCO, more than thirty years ago indicated the unstoppable progress of the schooling process, pointing to the ubiquity of education as a social problem "of our days, of our environment", in front of

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 229-255.

classical theoretical references that reduced it to "concept" (pp. 26-27). In the latest report commissioned by this body, *Reimagining our futures together*, aimed at "rethinking the role of education in key moments of social transformation" (UNESCO, 2022, p. V), the data corroborate this trend. Although the figures still show regional biases, their growth continues to confirm that "since the Second World War education has become the largest branch of activity in the world in terms of global expenditure" (Faure, 1977, p. 60), which leaves no doubt about the evidence that "the expansion of access to education in the world, since education was recognized as a human right, has been spectacular" (UNESCO, 2022, p. 20).

Such a proliferating presence of the educational is understood taking into account that education is mostly conceived as the main agent in the promotion of prosperity and social, even moral and cultural progress. So, however profound and convulsive, the changes in the structure of our societies may have been and are being the basic conviction about "the power of education to bring about profound change" or the "transformative potential of education as a pathway for a sustainable collective future" (UNESCO, 2022, p. III) which does not seem to have been undermined. However, this transformative potential does not seem to have been realized in the sense of bringing about the social change that the education reform has been promising for decades. It could be assumed that education is one of those institutions of the 21st century, and perhaps the one on which the greatest responsibility lies, whose ways of understanding and action, of producing and transmitting knowledge and of turning it into operations and practical interventions, are shown to be incapable of offering solutions to the challenges of the present. And this because *it continues to apply the same methods*.

The inadequacies and shortcomings of this educational model have stimulated numerous purposes of reform or innovation, sometimes aimed at implementing mechanisms of adjustment over the conventional paradigm, others aimed at total reformulations of its modern institutionality, accompanied by theoretical and philosophical theses of a critical, radical or revolutionary nature. The strong link established between schooling and the ideals of the developmental career –especially when development and cooperation programs were transferred to poor regions– promised social and political achievements such as modernization, prosperity, democratization, national integration, or respect for human rights (the latter being the central core of that modern subjectivity that the expansion of literacy would produce). But moments of global crisis at various levels would inevitably translate into questions such poli-

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 229-255.

cies and their educational correlates, the results of which fell short of their promises of well-being and democracy.

By the 1960s, the problems of the instituted schooling model were evident, in terms of teacher training, absenteeism, adaptation of the curriculum to the context, rural-urban tension, minority education and women's education (Hawkins, 2007, p. 148). This "traditional" school, in terms of master classes in which a group of students is taught following general schedules and programs – a consequence of the modifications of the second half of the 20th century (Reboul, 2009, p. 43) – was then the subject of numerous criticisms that tried to incorporate reforms and democratizing alternatives, which in some case reached, as is known, the extreme of the theses of de-schooling. The democratic optimism of the 1960s (Stevenson, 2018, p. 152) stimulated numerous attempts to design the kind of educational change that would address these mismatches; a period of incentives for reform during which "innovation" would be one of the magic words that most influenced school planning (Cawelti in Fullan, 2011, p. 2). Among other testimonies of that moment was the report of the Faure Commission, *Learning to be: the education of the future* (1972), which openly recognized the inability of improvements or adaptations on traditional education systems to withstand the criticisms they were receiving, as well as to consider without concern "those vast areas of shadow that mark on the planet a geography of ignorance […] a geography of hunger and child mortality" (p. 27).

Hegemonic innovation paradigm (educational)

Innovation, reform or renovation, are being offered as a response to the obstacles of education to fulfill this ambitious mission that has been assigned to it within the modernizing project. Undoubtedly, the purposes of renewal at various levels (curricular, methodological, organizational, roles of teachers and students) have been a constant since the progressive proposals advocated by the "new school" movement of the late nineteenth century. However, the urgent need to transform education in recent decades has acquired a character of local specificity and even urgency that makes it:

> Entirely new, no precedent can be found. It comes not, as has so often been said, from a simple phenomenon of quantitative increasing, but from a qualitative transformation that affects man in his deepest characteristics and that, in some way, renews him in his genius (Faure, 1977, p. 28).

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 229-255.

The difficulties encountered by the developmental educational model were answered, as noted above, by the innovative rise of the proposals of the pioneers of educational change of the 1950s and 1960s (Fullan, 2011, p. 1). Since then, the innovative process has not ceased, as it tries to be consistent with the demands and challenges of the new trajectories of societies, which correspond "to new knowledge, new rules of life, new organizations and new social relations" (Botrel, 1996, p. 250). Alluding to the exceptional nature of the change demanded, the Faure Commission (1972) pointed out the consequences without historical parallel of the scientific-technical revolution, the *mass media* and cybernetics. The structural and cultural transformations that have occurred since then emphasize this urgency, abound in the challenge of the traditional matrix of education (Avilés Salvador, 2020, p. 260) and urge us to understand the greater complexity of the changes: ecological crisis and imperatives of sustainability and greening of knowledge, the emergence of the knowledge society and transformations in the organization of work (Tedesco, 2014), the internet, digital revolution and social networks, and the most recent phenomena of post-truth, *fake news* and disinformation. Moreover, as the enveloping dynamics of all these crises, globalization and related processes contribute to the diffusion and reinforcement of the dominant paradigm, while strategically modifying it to adapt it to the needs of a globalized economy (Hawkins, 2007, p. 156).

As Tedesco (2014), a democratic, accessible education, oriented towards the personalization and construction of the learning process and critical reflexivity, based on social experiences and promoting capacities for social cohesion:

> It is an education substantially different from the traditional one, from the point of view of its management modalities and its contents. Transforming education is therefore the order of the day in most countries (p. 56).

There is no shortage of analyzes that, almost accompanying the reformist process for more than a century of criticism of pedagogical traditionalism, have been marking the reform with negative balances in terms of achieving deep and significant transformations. Caution – if not unmitigated recognition of failure – dominates in judging the ability of innovations to replace or alter the dominant educational paradigm, which has shown both an inflexibility and an ability to adapt and absorb the impact of change, possibly underestimated by reformers (Hawkins 2007, p. 155). With this "very new education that we all want, but that we cannot even

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 229-255.

remotely achieve for the moment" (Garrido Landívar, 1984, p. 137), the frustration in the 80s is portrayed by the scarce results of the proposals of the pedagogies of the 20th century. *Education holds a treasure* (Delors, 1996), collecting the witness of the Faure Commission, acknowledged the resounding failure of previous reformist attempts:

> As previous failures show, many reformers take too radical or too theoretical an approach and fail to capitalize on the useful lessons of experience or reject the positive legacy of the past […] attempts to impose educational reforms from above or from abroad were a resounding failure (p. 23).

After a few more decades of reforms and innovative projects, the conclusions of Rodríguez (2000) also left no doubt about the immovable educational scenario: "At this moment" the teaching does not reflect that "reality permanently sought, but never achieved. A goal that is presented as unattainable" (p. 455). Educational innovation does not seem to have been able to take off, according to the most critical diagnoses, from the pedagogical traditionalism denounced since the end of the 19th century or—from a broad and comparative perspective—to escape from the globalized hegemonic educational paradigm. Perhaps the modalities of change that is formalized and practiced are little more than the illusion of innovative and radical alternatives, because in some way they are produced and shaped from within the dominant paradigm (Hawkins, 2007, p. 157) and, in short, in one way or another, they end up succumbing and perpetuating the same methods as always.

The denunciations of failure or dissatisfaction with the timid achievements made in the face of the motley historical, institutional and normative panorama of so many perspectives and promises of educational change have also stimulated many attempts to elucidate the resistances and difficulties that prevent transformation. The analyzes have examined weaknesses and shortcomings in schools or innovative trends to point out their theoretical inadequacy to reality, practical inapplicability, obsolete or insufficient conceptual framework, or fragility to face greater forces (ideological, political, economic) that neutralize them.

We would now like to point out the possibility of collaborating with these analyzes from a perspective perhaps not yet sufficiently explored, in the idea of clarifying the reasons why the conventional model of teaching tenaciously resists. We start from the fact that some categories or syntagms have taken control of the discourse and have monopolized

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 229-255.

the landscape of available formulas and, with it, the faculty to refer and certify the possible realities. In naming the need for change in education:

> The words innovation, change, reform (capitalized and singular), reforms (minuscule and plural) and renewal, although they do not mean the same thing or serve to name the same pedagogical practices, move din very close semantic fields (Martínez Bonafé, 2008, p. 78).

It would be possible to ask whether the irruption and consequent ubiquitous presence of the term innovation for some decades in the dominant, academic, institutional and legislative discourses (Fernández & Jasso, 2023) have induced any major alteration in the conditions of what is collectively accepted as education reform. The question is pertinent in view of the fact that the pedagogical discourse of innovation has been established quickly and without many obstacles in the political agenda, crystallizing in normative frameworks aimed at modifying teaching and organizational practices (Quilabert *et al*., 2023, p. 59). The preference for innovation as a privileged textual brand has displaced other notions that seemed well established in the theoretical and practical tradition of educational change, which only adds perplexity to the already plural and contradictory history of the alernatives of pedagogical renewal of the twentieth century (Garrido Landívar, 1984; Rodríguez, 2000; Luelmo del Castillo, 2018). This situation has raised useful suspicions and criticism about the superficial and even conservative nature of the innovative process and discourse:

> It may be that the same notion and its respective socio-political, institutional and educational companions do not operate as a fetish, a claim or a label; as a simplistic way consisting of equating the new with the good, in confusing appearances with the most profound transformations that would be desirable, relevant and fair (García Gómez & Escudero, 2021, p. 5).

These reflections—which investigate the conceptual problematicity of the idea of innovation, in contrast to other semantics of change—are incomplete if a more comprehensive and complex look is not cast on a larger problem, which overflows the educational fact, but which conditions and distorts it. Taking as a horizon of reflection the methodological activism and the contextual implication of learning, which have been placed from the origins of the renovating impulse as a key to understand and enable the socio-educational transformation, it is considered that it would be pertinent to stop in the analysis of the concept of innovation

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 229-255.

(dry). Elaborating a critical perspective about the history of innovation, its itineraries in the past and the perspectives and possibilities of evolution towards possible futures can contribute to better understand the confusion and mistakes around educational innovation and better guide the desired trajectories. It can then be said that the notion of innovation has acquired the category of paradigm, if we understand the latter, in a broad sense, as an encompassing idea that goes beyond simple theory, as concatenation of assumptions that crimp into forms of transversality, or as a certain organization of conceptualization with consequences for research (Follari, 2003).

In this way, it could almost be said that innovation or the idea that has been canonized from it, as a paradigmatic function, is taken uncritically as a value in itself, loaded with strong normative connotation and social desirability, and associated with presumably positive values (Quilabert *et al*., 2023, p. 75). This opacity of its problematic consistency hinders its conceptual articulation and the critical approach of the condition of innovative discourse as a structuring factor of networks of purposes and justifications, which legitimize both research trends and some fundamental laws and discourses, which design and channel the evolution of our societies, social change and progress. Innovation is seen uncritically as a good thing and is conceived *a priori* without thoughtful intermediation, as a panacea to solve a wide range of socio-economic problems, from the financial crisis to climate change or from health issues to well-being in developing countries (Ufer & Godin, 2018, p. 62; Blok, 2021, p. 73).

A large number of provisions and devices, at very different levels, give concrete expression in the phenomenal world of social life and its textual productions to this paradigm of innovation, and especially for what interests us, regarding the organization of knowledge, the social distribution of knowledge and its organization from centers and networks of economic, institutional and symbolic power. The incomprehensible collection of discourses that refer to innovation can be characterized by a certain regularity in dispersion, while in some way all of them refer to the same object, share in some degree a common style in the production of statements, and a verifiable recurrence in the use of concepts, categories and expressions that refer to common themes. On the other hand, this dispersion suffers from inconcretion, from the lack of a sufficiently developed and dialogized theoretical framework, from conceptual clarification and from axiological orientation (Palacios Miele, 2020). These shortcomings and forgetfulness risk turning innovation, from a necessity for change, into an empty gesture marked by discursive inflation and the

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 229-255.

saturation of institutional and financial efforts that, to a large extent, and for this reason, are ineffective, burdensome and generate rejection and social fatigue. It is not surprising that—from perspectives committed to critical thinking about the values of innovation—this process has been denounced by the inflationary use of the term (Pacho, 2009, p. 34), by its superficial character of mere fashion or fetish, or qualified as "innovofilia" (Gracia Calandín, 2017, p. 15).

The uncritical assumption of innovation does not establish the premises for an axiological neutrality, but it is precisely its paradigmatic condition that authorizes "supralogical" principles of thought organization that concealingly "govern our vision of things and the world without our being aware of it" (Morin, 2005, p. 28). For this reason, the concept of innovation, which seems to have established itself as a dominant discourse for some decades to describe and mobilize social change and progress, is guided by principles that most innovation scholars identify by their techno-economic and market-oriented character (Echeverría & Merino, 2011; Ufer & Godin, 2018; Blok, 2021; Schomberg & Blok, 2021). This assumption, in turn, implies a linear model that understands that innovation only comes from scientific research, which is well reflected in the famous acronym R+D+i (Echeverría & Merino, 2011, p. 1031).

From a historical perspective, the concept of innovation has a long trajectory and goes back to antiquity (Aguilar Gordón, 2020b and c), referring to the idea of novelties or ruptures, both in cognitive and social aspects and in the broadest sense of the word (imitation, invention, creative imagination, change), and only recently has it been restricted to technological innovation (Blok, 2021, p. 75; Echeverría & Merino, 2011, p. 1032). As Godin's works demonstrate, innovation has historically had an intense negative connotation for the destabilizing force of the novel, as a rupturistic incorporation into the bosom of a stabilized political organization, which was received with caution and resisted by conservative inertia; it is only after the beginning of the 19th century that the concept gradually enters into a context, widely welcomed and appreciated, of progress and utility. Likewise, the field of commercialized technologies will be more present in the daily discourse of innovation as the dominance of the hegemonic economy becomes more prominent and the concept is shaping its meaning in terms of goods and technological products (Schomberg & Blok, 2021, p. 4676). After World War II, policies, management, and business further tied innovation to the market, making "technological innovation" the most common meaning today (Ufer & Godin, 2018, p. 70).

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 229-255.

One of the interesting consequences of this evolution is that the notion of innovation has been losing critical potential, while its semantic density has been gaining in inconcretion and polysemy (Aguilar Gordón, 2020b, p. 22; Martínez Bonafé, 2008, p. 79; García Gómez & Escudero, 2021, p. 5). This fact makes innovation a clause adaptable to any disciplinary discourse and apparently open to a variety of modalities of incorporation of novelty into products and processes, favoring as a consequence the implicit acceptance of its commercial technical bias, of little self-reflexive problematicity and of a conditioning nature. As the world and the dominant economic-business languages have been assimilated, innovation, while being subject to "pure scientism and technicality" (Aguilar Gordón, 2020c, p. 272), has also become depoliticized and covered up with that self-evidence that consecrates its goodness prior to conceptual analysis or any type of evaluation of its effectiveness or suitability, other than the parameters for measuring success assigned by the market. As Echeverría and Merino (2011) affirm, the economist paradigm that has prevailed in policies and innovation studies since the 1980s, is based on two principles: creating value from innovation consists in creating economic value and the agents that perform this function are companies, i.e., "the success or failure of technological innovations manifests itself in markets" (p. 32).

Perhaps an analogous evolution could be sustained as a thesis with which to confront, as said above, the general idea of innovation and its study, with the mutations that educational change has suffered until the current equation of all pretensions of pedagogical reform with educational innovation.

Towards a new social paradigm of educational innovation

In these last sections a proposal for reflection will be tested that tries to build a theoretical contribution in the field of educational innovation, which while trying to join the works mentioned here and those who continue to reflect in this line, will also try to provide a foundation for innovative teaching practices already existing and to design within innovative projects. The proposal outlined so far on the philosophical problematization of the notion of innovation and the need to constitute a philosophy of educational innovation can identify areas of practical-methodological operability in pedagogical activism and in the most recent active learning methodologies. The latter are understood as the methods, techniques

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 229-255.

and strategies used by the teacher to promote the active participation of students, aimed at learning both generic skills and aspects of specific disciplines (Puga Peña & Jaramillo Naranjo, 2015). In particular, these suggestions aim to conceive methodological proposals as suitable tools for educational spaces to become agents of the social turn of innovation.

It can be said that educational change responds to the very complex bioanthropological characteristics of the human being in its cultural and linguistic constitution, determined by the biological, psychological and moral incompletion of the human being. It corresponds to the phenomenon of education, understood in its varied and historically determined forms of phenomenical manifestation to be deployed as the necessary process of incorporation into a cultural context of the students, within the framework of socialization patterns and behavior. These are never definitively and conclusively stabilized by the constitutive indeterminacy of the human and the productively creative character of its existential and cultural work: "The internal or structural historicity of human culture is but the other name of its permanent innovation, of its mobility, its volatility or, what is the same, its permanent creativity" (Pacho, 2009, p. 35).

Educability, understood as a process triggered by the ontological precariousness of the human being, will be corresponded by the phenomenology of educational, cultural and socially located facts in their singular pluridimensionality, uncertainty and transience, which inhibits that educability is applied from a normativity that categorically closes the human: "The pedagogical discourse on innovation in school is very old, and in its becoming shows the tensions between desires and possibilities in the social field of education" (Martínez Bonafé, 2008, p. 79). It is for this bioanthropological condition of education and its dynamic, creative and contextual character, so that educational innovation, analogous to what happened with innovation (at face value), would resist the reductionism of its possibilities to a techno-economic and efficiency paradigm. In this sense, it has been possible to affirm about the evolution of theories and practices of educational change that "the tools we have in current innovation are those that respond to what the market demands and the proposals of neoliberal economics" (Martínez & Rogero, 2021, p. 73). Not infrequently, innovative design is carried out with the back to those processes that nourish the educability of the person, specially the relationship with other human beings and with their environment, through which it develops and who, finally, directly or indirectly, receive the results of the educational potential deployed. Hence, the advances that have been developing in the field of innovation studies and the efforts of those who try

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 229-255.

to build a philosophy of innovation that critically and in depth explores this concept, in its historical, political and institutional implications, and in its ontological, epistemological and axiological planes (Aguilar Gordón, 2020b, p. 22), should have consequences in the task, also to be done, of elaborating a philosophy of educational innovation (Aguilar Gordón, 2020a), an inexcusable effort to promote the true desired reform.

A genuinely innovative education, based on ethical premises and the consideration of the anthropological dimension of the phenomenon (Higuera Aguirre, 2020), would be one oriented from and for collaboration, meaningful inquiry and substantive involvement in a creative process in the critical management of information, actively aimed at stimulating the global and integrated commitment of each educational actor with the aim of transforming society (Pozuelos & Rodríguez, 2021). However, despite the long history of the "new school" approaches (Marín Ibáñez, 1976) and the educational innovation that emerges from it – and that is prolonged and promoted recently with the inclusion of ICT in educational practice, there remain ways of understanding and practicing education that could be described as traditional, uncritical, fragmented and inflexible (Bona, 2021 in Cruz & Hernández, 2021), where teachers "teach" and students "learn" and are evaluated through standardized exams.

Faced with these resistances, the challenge for change should be oriented to build every day another school, a different school, where educational innovation emerges and is lived as a process from the inside out, where teachers and students are the ones who practice new ways of learning, analyze the results and continue transforming into a process of continuous improvement and constant collaboration (Pozuelos *et al*., 2010). In this way, they can germinate collaborative dynamics and subjectivities that overcome the immobility and resistance of traditional educational models, realizing precisely the inadequacy of the linear notion of innovation, by testifying that very diverse and heterogeneous spaces of social and educational life are highly creative sources of educational change.

This situated and proactive innovation can account for experiences that promote diverse ways of feeling the educational, of initiating theoretical formulations, of counteracting or saving barriers and known deficiencies: technical training focused on disciplinary contents, thoughtless repetition of previous educational experiences, lack of support for the transition, standardized external tests for the classification of educational centers, inadequate working conditions for educational transformation, bureaucratization of teaching practice, hegemony of the textbook or, of course, individualism and reluctance to collaborative work between teachers.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 229-255.

Continuing with this idea, some of the spaces and actors of the educational systems from where innovative designs would emerge, so that innovation can be truly transformative, is the teaching staff as a community of interaction where research-action synergies occur. Any innovative action thus understood will subsequently have to be analyzed, debated and reorganized, in collaboration and joint feedback, so that complex systematicity replaces the simple linear vision. The permanence and continuous improvement of innovation depends on this. Jaume Carbonell (2015) focuses his attention on alternative proposals for educational innovation of the 21st century that, unlike the most relevant pedagogies of the previous century, are characterized by being generated and driven by educational networks, i.e., collectives where flows of exchange and collaboration are experienced. These are pedagogies that seek to improve the relations between the different educational actors, inside and outside the institutions, favoring a close collaboration and reciprocity with the territory and promoting processes of cooperation, participation and democratization in the educational institution. Bringing the institution closer to social reality, the educational process is sought to be stimulating and meaningful in the configuration of a free, responsible, creative, critical citizenship, balancing the participation of all dimensions of the person.

Likewise, Pozuelos *et al*. (2010) mention some characteristics of educational institutions and networks of educational actors that are carrying out silent innovation: illusion and hope; slow and constant pace; integration of contents that go beyond the basic subjects; construction of homogeneous collectives; presence of shared leadership and collaborative work; reflection and research process that transform their own educational reality; complementarity of practical and critical knowledge; openness to school and the community; presence and participation of diverse professionals and experts in the processes of the center.

In order for the innovative educational process to be carried out, it is necessary that people are involved and are protagonists of the experiences (Michavila, 2009), that spaces of coexistence are created for the feedback and evaluation of the community interventions involved (Marcelín Alvarado, 2023), that capacities are fostered to put knowledge, skills, attitudes and values into play; i.e., an amalgam of competences that, while fulfilling a function for the solution of real situations, continue their course towards their strengthening and extension to new contexts and approaches.

To avoid new proposals falling into dogmatisms or simplifications, it is necessary to approach educational innovation from a critical and analytical point of view, which problematizes the need and suitability of

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 229-255.

this type of practices to achieve learning, well-being and personal and social transformation. For this reason, it is considered essential to relate dialectically two poles or complementary aspects of the problem: on the one hand, the criticism of educational innovation as only implementation of novelties at the level of materials, techniques and procedures at the service of the market, without substantive challenges of the hegemonic model and without being linked to a teaching ethical commitment, nor to a transformation of the unjust and unequal social reality; on the other hand, an analytical clarification that tries to delineate, from limitations and barriers, the criteria, conditions and demands that would make the desire for change an authentic transformative, democratizing, emancipatory, inclusive and participatory innovation (Martínez Bonafé, 2008; Rogero Anaya, 2016; García Gómez & Escudero 2021; Díez Gutiérrez *et al*., 2023; Hargreaves, 2022).

As a counterpoint, it is important to review experiences in contexts located from silent proposals but committed to social environments that give meaning to the renovation projects of educational centers, which can put us on notice of an opening to encounter with already acting processes that are truly innovative. This does not omit the fact that they were originally encouraged by this "innovative fever promoted from above" (Rogero Anaya, 2016, p. 7) and does not exclude that coming from the business environment —such as the most recent active learning methodologies— they are creatively resignified in transformative education practices.

Although active learning is still not a widespread reality in higher education today, there is no shortage of studies that have been demonstrating its short- and long-term benefits. Some studies have found positive consequences in the improvement of strategies and approaches to learning in university students (Barboyon Combey & Gargallo López, 2022), as well as higher performances in academic performance: final grades, terminal efficiency of the subject and competence development (García Merino *et al*., 2016; Pino & Fernández, 2016; Carcelén, 2019; Deslauriers *et al*., 2019). Also the results of Robledo *et al*. (2015) suggest that those active methodologies with greater demand, activity and autonomy of students promote the development of their competences. Moreover, innovation with social consequences has also been demonstrated, for example, in Theobald *et al*. (2020), who conclude that in environments where activism is promoted, the performance and permanence gaps between university students, members of minorities and the rest of the group are exponentially reduced, being especially significant in STEM subjects. Increasing success in learning requires that students spend most of their

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 229-255.

time solving complex and meaningful tasks; that they live a culture of inclusion that provides the necessary supports to young people with specific needs; that they immediately feed back and thus transfer genuine interest and confidence in their chances of success to students (Theobald *et al*., 2020).

Below, we briefly present some of the active methodologies, emphasizing their characteristics to promote the design of educational innovations aimed at addressing the curriculum in an integrated way, to promote globalized learning and to stimulate the degree of participation, commitment and learning:

- *Service-learning*: methodology that promotes the development of social and civic competences through the service to the community that students perform based on their academic training. The purpose is to raise awareness and responsibility of the educational community about its role in the transformation and improvement of the environment (Martínez *et al*., 2018), making learning a consequence and at the same time a means for it. It is characterized by promoting proactivity, cooperation, problematization, relationship, reflection and transformation (Martínez Usarralde, 2014; Santos Rego *et al*., 2015 in Álvarez Castillo *et al*., 2017). This methodology has proven its usefulness, both in the advancement of learning and in the attention to social needs, while increasing the networks of collaboration and co-responsibility, so necessary in contexts of growing tension and inequality.
- *Problem-based learning*: problematic situations are a powerful tool for learning, as they arouse interest and curiosity to understand and respond to the situation posed, favoring motivation, involvement and commitment throughout phases that lead participants to meaningful learning. This methodology has been widely used since the 1960s, especially in health studies, having as its main advantages the relevance of training related to current problems, increasing motivation and responsibility for learning (Jones, 2006).
- *Project-based learning*: it is based on the questions of students about different facts, phenomena and needs of their social environment. Taking advantage of their interest and motivation, the involvement of students in a systematic and at the same time flexible process is favored, which includes different expe-

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 229-255.

riences, tasks and educational productions aimed at answering their questions and producing a result, which usually consists of a tangible object to solve a particular need or problem (Pozuelos & García, 2020).

- *Challenge-based learning*: it is the most recent proposal that brings together the best of the previous ones; it allows to pose a problematic situation or challenge to generate a complex and totalizing design about how to achieve the solution through learning and practicing different competences. The selected challenge relates to real social needs in the context of students, so that the dynamic innovation process that is launched makes effective the characteristics of the innovation necessary for the 21st century: relationship with the needs of the context, link between people and institutions, significance of experiences, involvement and shared practice of complex competences. This learning is relevant to respond to the central interest of this work about the need to critically address the notion of innovation and its role in the educational field, since this method has gone from being a concept coined by a multimillion-dollar technology company (Apple), to be a methodology whose application in higher education is growing. We agree with Leijon *et al*. (2021, p. 616) in the idea that when this approach is used as a framework for educational interventions and not for social impact, a central component of this methodology is lost. Even if the latter may be the hardest aspect to push, higher education institutions as promoters of knowledge in a learning society that should accept the challenge.

University and activism in higher education

In our current societies, it is increasingly necessary for university professionals to act competently, responding ethically to the great challenges they face, both global and local. For this reason, and without excluding other innovative strategies oriented by similar commitments, the pedagogical reform proposal based on active methodologies could offer adequate tools to address the mentioned threats, as they would act as enhancers of the active involvement of students to address real situations, many of them problematic (Arruda *et al*., 2017).

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 229-255.

Through these methodologies, it is intended to build a series of experiences in which the student is at the center of the process (Gutiérrez Pozo, 2023), involving himself individually and in groups in each of the phases, building meanings to respond to a need or the resolution of a situation that awakens his interest and motivation (Silva & Maturana, 2017). There are several techniques and resources possible for the strengthening and diversification of the proposed activities (problems, projects, services, challenges) in order to meet the needs of young people and the community, encouraging the interest and involvement of participants in decision-making and the development of tasks, being able to count on the support of ICT as facilitators of communication, search and management of information, as well as the creation of responses with digital means. It is worth emphasizing the proposal to conceive active methodologies from their link with the wide tradition of pedagogical renewal that precedes it (Marín Ibáñez, 1976; Rodríguez, 2000; Luelmo del Castillo, 2018) to think and test their acclimatization to the complex and changing premises. From this dialectical position (Reboul, 2009, p. 17) which assumes the tension between continuity and rupture, we can think of educational innovation and proposals for active methodologies as a more complex and committed process than that which would offer us its single location in the techno-scientific paradigm and the linear model.

Rodríguez (2000) proposes that the permanent failure of educational innovation through the implementation of activism in education has as its main factor the diffusion of active models through passive mechanisms, such as pure perception, reading and request for faith by those who must put it into practice inside and outside the classroom. Again, it is necessary to involve the faculty in decision-making, as well as participation in real experiences in which the results of these actions are felt and assumed, after negotiation processes, as benefits for all involved. Another aspect that can reinforce the creation and proliferation of educational spaces and environments conducive to the generalization of educational activism is to eradicate the emphasis on individual measurable benefits as the goal of learning. In line with the proposed social shift of the innovation paradigm, the emphasis on the collective, as a determining factor for human well-being, should regulate innovative discourses and practices in education. It is a question of looking back at the axiological horizon of formation, especially university education: society and personal autonomy. The latter only makes sense in the space of social interaction, where it develops and progresses morally and materially, and which serves from its professional competencies. This means putting at the center

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 229-255.

the value of educational innovation as a key component to achieve university commitment to social improvement. Likewise, strengthening the critical and complex view on the phenomenon of education from the social, anthropological and philosophical must contribute to construct the sense and moral motivation necessary to weave the networks of human relations and shared commitments that enable the type of innovation that can be authentically transformative.

Some conclusions

Just as the generic concept of innovation has evolved towards a systemic model that understands that the innovative impulse originates from complex interactions between individuals, organizations and operating environments (Echeverría & Merino, 2011), we understand that theoretical and practical efforts must converge so that educational innovation follows this same socializing course, with more participatory, interdisciplinary and practical educational models (Michavila, 2009). Many challenges remain for educational innovation to meet, as proposed by UNESCO, the ambitious perspectives placed on its transformative potential towards a sustainable and more humane collective future. But this task cannot be approached with solvency and legitimacy if the treatment and response to substantive and radical questions is avoided for the purposes of education and, particularly, for the complex condition of the idea of innovation and the values that mobilize it in the field of education. However, "philosophical reflection on innovation is still in its infancy" (Blok, 2021, p. 74). Taking on this difficulty, we have tried to contribute with this work to the ongoing collective effort that seeks to respond to this theoretical lack in the field of innovation studies, but also understanding that reflection must be opened to the problematic encounter with its pretension to give foundation to innovative practices, and that it must critically reverse itself in function of the results operating in the interests of this social transformation.

One of the strengths of this work has therefore been to advance in the effort to build a philosophy of educational innovation that can find spaces of practical-methodological operability in pedagogical activism and in the most recent active learning methodologies. Education, as part of civil society and as a meeting place for different social actors (including scientists, organizations, companies...) can play a leading role in generating and driving innovations necessary for social change. A space of complex interactions in which, thanks to active learning and the

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 229-255.

methodologies related to it, only educational is transcended to contribute to the clarification and development of innovations that generate social capital (Lundström *et al*., 2017). This would be a real change in the paradigm of innovation, which would be in line with an education that would assume the ambitious achievements that Modernity entrusted to it and to which perhaps, despite failures and difficulties, and less now than ever, it should not give up. Education would be considered not only as one more area of innovation, but as that basic force that stimulates, energizes and sustains the innovations that 21st century societies, democratic, pluralistic and intercultural need.

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Contributions of the Frankfurt School and Edgar Morin to Promote Dialectical and Complex Thinking in Education

Aportes de la escuela de Frankfurt y Edgar Morin para fomentar el pensar dialéctico y complejo en la educación

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Abstract

The aim of this paper is to present an educational proposal that challenges the way adolescents in school think, and, consequently, how they relate to uncertainty, change, and otherness. To this end, the text starts from the formulation of a "method" –a key term in this work– based on the philosophies of the Frankfurt School and Edgar Morin, which can address the multidimensionality and multireferentiality of reality: dialectical and complex thinking. It is believed that only such a way of thinking, one that turns the individual into a strategist, will produce citizens capable of taking responsibility for their democracies. The connection between education and politics is clarified, with the first positioned as the foundation and engine of the latter. The educational proposal for forming complex citizens is then described, which is based on the recovery of a profound culture capable of deepening adolescents' thinking and distancing them from simplistic and totalizing discourses. Finally, it is concluded that the only way to avoid new barbarities, such as Auschwitz –both as an extermination camp and, more importantly, as a metaphor for the place knowledge can lead without an educated thought to guide it– is to promote an education for complexity, understanding, and freedom.

Keywords

Dialectic, Complexity, Democracy, Barbarism, Education, Method.

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Index h: 1

Resumen

El presente texto tiene por objetivo plantear una propuesta educativa que complejice la manera de pensar de los adolescentes escolarizados y, por lo tanto, su manera de convivir con la incertidumbre, el devenir y la otredad. Con miras a ello, se parte de la formulación de un "método" –palabra clave en este trabajo– basado en las filosofías de la Escuela de Frankfurt y Edgar Morin, que sea capaz de hacerse cargo de la multidimensionalidad y multirreferencialidad de la realidad: el pensar dialéctico y complejo. Se considera que solo un pensar de estas características, un pensar que convierte al sujeto en estratega, construirá ciudadanos capaces de hacerse cargo de sus democracias. Se procura esclarecer la conexión entre educación y política para poner la primera como base y motor de la segunda. A continuación, se describe la propuesta educativa para formar ciudadanos complejos, la cual se basa en la recuperación de una cultura profunda capaz de complejizar el pensar de los adolescentes y alejarlos de discursos simplistas y totalizadores. Finalmente, se concluye que la única manera de evitar nuevas barbaries como la de Auschwitz –como campo de exterminio, pero, sobre todo, como metáfora del lugar al que se puede llevar el conocimiento sin un pensamiento educado que lo guíe– es promover una educación para la complejidad, la comprensión y la libertad.

Palabras clave

Dialéctica, complejidad, democracia, barbarie, educación, método.

Introduction

> *My deep conviction is that the future is not written anywhere; it will be what we make of it. ¿And fate? For the human being, fate is like wind for the sailboat. The one at the helm cannot decide where the wind is blowing from, or with what force, but it can orient the sail. And that sometimes makes a huge difference. The same wind that will wreck an inexperienced, reckless, or ill-inspired sailor will bring another to good port (Amin Maalouf).*

This text will address the connection between the education received and our way of acting as citizens. To this end, it will be based on the premise that educational curricula should aim to train complex citizens capable of taking charge of complex societies. The defense of human dignity and resistance to all kinds of oppression must be postulated as the main objectives of any educational exercise so that Auschwitz—both the historical fact and the metaphorical fact—cannot be repeated. To this end, the work of the Frankfurt school and Edgar Morin will be used to base the following idea: only the transmission of a dialectical and complex "method" in education—a method that grants the ability to invent strategies to face a changing context, a method that replaces education as a "program" (solid and deductible guidelines that must be followed in any context)—is suitable for creating complex individuals, capable of actively

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participating in their democracies. The transmission of this method, then, will be defended in this work as the mission of all education that is worth.

Collecting the teachings of Morin (2003), this method will be presented as a path that is invented at every moment and that invents us in every context in which we put it into practice. The method, understood as a tool to create strategies, both in the field of knowledge and action, will be exposed as the way to organize and contextualize the knowledge and decisions of individuals in their day to day. Only through a dialectical, modifiable and complex method can civilization survive successfully, "a humanity that develops through a contradictory and complementary tension of two globalizing helices: the quadrimotor (science, technique, industry and economic interest) and humanist and emancipatory ideas of man" (Morin, 2003, p. 11).

Dialectical and complex thinking will be presented as the natural basis of the method described. According to the Frankfurt school, dialectical thinking is a way of approaching, both knowledge (*episteme*) and action (praxis), a type of thinking that starts from and takes into account the internal contradictions of one and the other. Nothing is as rational, coherent or closed as the totalizing theories about reality defend, say those of Frankfurt (Horkheimer, 2015, p. 218). Every human and social phenomenon is crossed by different logics that fight each other and contest each other. This, as we will see throughout the present study, can lead us to two positions: petrification by being before an uncertain and mutant world or the advance towards more complex forms of understanding and action.

This paper will navigate between the main texts of the Frankfurt school and Edgar Morin, according to their relevance for each issue to be addressed. The first block presents the dialectical and complex thinking from both philosophies. The second block, devoted to complexity, presents more from Morin's teachings. The third block, dedicated to the educational proposal, will be based on the studies of the Frankfurt school a century ago in the face of the rise of radicalism in Germany. The fourth and fifth blocks, dedicated to the Auschwitz metaphor and conclusions, will present the teachings of both philosophies and demonstrate their connection with the mission of education today.

Dialectics and complexity as two sides of the same coin

Dialectical and complex thinking, rather than a methodology, is an attitude, a way of looking, a strategy to look for tools that allow us to assimilate

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

an uncertain, unpredictable and constantly building world. If reality is open and transforming, there must be a method to approach it. A conception of this method as a closed program is insufficient, because in the face of changing and uncertain situations, programs are not enough, however, the presence of a thinking subject and strategist is necessary (López Pérez, 2023a, p. 203). For this reason, the method cannot be arranged before one's own experience, as aprioristic rules that can be used in any situation: the method emerges *during* the experience and, perhaps, can be theorized in the end.

To be able to use a relevant method in each specific situation, the subject needs theory, different knowledge learned through education. Here it is important to understand what theory is for the Frankfurt school and for Edgar Morin and how theory relates to education and to the very creation of the method. Theory is what allows us to think, what forms our categories of thought, what determines the *episteme* with which we observe the world. Theory is not knowledge: it allows knowledge. The theory is not an arrival: it is the possibility of a departure. Theory is not a solution: it is the possibility of treating a problem. The theory only fulfills its cognitive role, it only acquires life with the full use of the subject's activity: the theory turns the solidified individual into a strategist, as explained by Morin (2003, p. 25).

The Frankfurt school's defense of theory does not support theorization—remaining in mere speculation about reality—but seeks to show that theory must precede concrete action in order to give it a course. There is no definitive theory or definitive action, but action must be constantly reviewed by a theory capable of testing its legitimacy and its relevance. The theory itself must be assiduously reviewed and contrasted by reality, so as to show that it is still capable of interpreting what is in front of it (López Pérez, 2023b, p. 169). Any theory endowed with some complexity can only retain its complexity at the price of permanent intellectual recreation. The theory that is not revised risks being degraded, i.e., simplified. As Morin (2011, p. 51) indicates, what does not regenerate degenerates. Any theory abandoned to its theoretical content tends to be flattened, unidimensionalized and reified: theory must always retain the lightness of the transformation. Jorge Wagensberg (1994) said:

> A plan for the acquisition of ideas is only good if it continually tempts us to abandon it, if it invites us to deviate from it, to sniff out right and left, to turn away, to wander around, to let ourselves be led not to obtain ideas but to treat them (p. 17).

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

Theory is the fundamental principle of dialectical and complex thinking, as it allows different perspectives and levels to be visualized. What it is about is to enable the subject to think, in the same space-time, logics that complement each other and that at the same time can be excluded. It is about thinking in recursive and dialogic movement to position ourselves against the thinking of fragmentation, disarticulation and censorship, which causes us to lose the ability to understand phenomena not reducible to a single logic or dimension.

Dialectical and complex thinking educates individuals in strategy, initiative, and the invention of new patterns of action to move in reality. This method then creates a recursive relationship between individual and society. We outline, therefore, a first approach to the method-program opposition that we have gradually introduced. The program is a default organization of the action; the method finds resources and detours, makes investments and diversions. The program repeats what is always the same (Adorno & Horkheimer, 1998, p. 80), i.e., it needs stable conditions for its execution; the method is open, evolutionary, it faces the unforeseen, the new. The program does not improvise or innovate, the method improvises and *innovates.* The program can only experience a weak and superficial dose of *alea* and obstacles in its development; the method is deployed in the most random situations, uses the *alea*, the obstacle, to achieve its ends.

The method is the work of an intelligent being who tries strategies to respond to the situations with which he is encountering. In this sense, to reduce the method to program is to believe that there is an *a priori* way to eliminate uncertainty from the context. Gaston Bachelard (2000, pp. 121–122) said that all discourse of method is always discourse of circumstances. This means that you cannot create a program that works in all contexts, but you can educate individuals to *learn*, through a reviewable method, *how to manage* uncertainty and unpredictability.

Dialectical and complex thinking is also an activity of organized spiritual resistance that, as Adorno said (2019, p. 79), implies a permanent exercise against blindness and annihilation generated by the conventions and clichés established in society. Because of this, dialectical and complex thinking is not just a strategy: it is above all a generative tool of their own strategies. The idea of strategy is linked to that of the *alea* (in Latin it means dice, gambling, risk, luck and uncertainty) and the *aleator* is the player of profession, i.e., one who can take advantage of the *alea* to achieve their ends.

Dialectical and complex thinking is the only one capable of overcoming seemingly insurmountable alternatives not by avoiding them, but

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

by placing them on a richer horizon that gives rise to new possibilities. These possibilities arise when the anti-which seems anti-gaze from a simplifying perspective--is articulated in the meta-in a broader context that may contain within it different ideas in friction. "Only an educated mind can understand a thought different from its own without the need to accept it," said Aristotle (2001, p. 139). Dialectical and complex thinking is able to coexist with contradiction and antagonism without suppressing them, integrating them into a horizon in which they can continue to ferment through their constructive and destructive potentialities.

Unlike simplifying thinking, which identifies a single logic with the act of thinking itself, dialectical and complex thinking avoids the fragmentation and disarticulation of acquired knowledge (Morin, 2003, p. 71). In this sense, this thinking does not stand as a "new logic", it uses logic, but transgresses it. Or the same: it shows other ways of articulating logic(s).

In this way, dialectical and complex thinking and logical thinking are placed at the antipodes. Following Adorno (1973), logical thinking would be based on Aristotelian logic dictating that A = A under any context and circumstance. This means that every element of reality is "essentially" the same thing at all times in its history. Neither context, nor time, nor self-determination can modify the essence of the elements: they can only modify their accidents. Therefore, and although at first glance something seems to change over time, in reality it only changes its appearance, while its essence is unchangeable and it is headed for a predetermined end in advance. Because of this, their processes are deductible and, if we find the right method, we can foresee them. Inventiveness, creation, and intervention have no place in such thinking. Garaudy (1970) describes the difference between dialectical and logical thinking: "Dialectical reason is first reason becoming, as opposed to a rationality already constituted, with its immutable laws such as those of formal logic" (p. 59).

Dialectical and complex thinking breaks with the dictatorship of predetermination and the immutability of logical thinking. Dialectical and complex thinking is relevant where we find the need to articulate, relate and contextualize elements that are transformed. Dialectical and complex thinking is relevant where you have to think. Where you cannot reduce the real to either a logic or an idea. Where you seek to find something more than you knew in advance. Where we seek not only to understand what is in front of us, but also new guidelines to act on it. The vault keys of dialectical and complex thought arise from the encounter between formidable antagonistic pushes. Therefore, it is necessary that all

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

education start from the *awareness of the multidimensionality of reality*, therefore, of the unfinishing of thinking; in this way, individuals will not try to hide this unfinishing, but will point it out and take care of it. Thus, it should be noted that:

> Knowledge, like life, is an endless quest. A search in which we are also finding some ports of arrival and rest and that serve us to, looking back, recapitulate and see what is serving us and what we can eliminate in that search. See what strategies proposed are serving us in our business with reality and what strategies are disposable (Roger & Regalado, 2016, p. 17).

If, as Pascal (1981, p. 81) said, the good to think reality is the basis of ethics, it is necessary that we make good, adequate, pertinent readings, as little reductionist as possible, of the context to act in the most civilized way possible. "Reducing a whole to one of its components is an intellectual fault, and this is worse in ethics than in science" (Varona, 2020, p. 103). It is necessary, therefore, not only to look, but above all to know how to look. Or as Montaigne said (2005, p. 155): what we need is "to educate the gaze". For knowledge is not the sum of data, but the conscious organization of it. In this sense, we cannot speak of recipes, but of general mental skills that serve us in the mobilization of thought towards the construction of knowledge as least simplistic as possible in the contexts in which the subject is located, where the constancy of the medium can never be assured (Roger & Regalado, 2016, p. 32).

Diagnosis, understanding and context management go hand in hand. Although uncertainty is always there and it is impossible to make a total and absolute reading, it is possible to read the context as pertinently as possible, and this is an exclusively epistemological question. The only way to reduce uncertainty, or rather manage it, is to increase mental complexity. It is the subject who must be complex: who knows, who makes mistakes, who can provide not recipes, but means-strategies as relevant as possible to establish relationships with reality.

From an etymological point of view, the word "complexity", of Latin origin, comes from *complectere*, whose root *plectere* means "braiding" or "linking" (Joaqui & Ortiz, 2020, p. 163). The addition of the com- prefix adds the sense of duality of two opposing elements that bind intimately, but without overriding their duality. Complexity, therefore, "is a tissue of heterogeneous inseparably associated constituents, which present the paradoxical relationship of the one and the multiple" (Morin, 2003, p. 54). The word "dialectic", meanwhile, comes from the Greek *dialektik' tékhnē*, which means "conversation technique". Dialectics is the art of contrasting

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

a certain idea, conception or tradition, understood as a thesis, with others other than it, understood as antithesis. From this confrontation arises, in a third moment, the synthesis, a new understanding of the problem that, more than a solution, amounts to a new level of complexity of the problem itself. Complexity and dialectics arise, as well, as two parts of the same process and are summarized as the activity of articulating dissimilar elements whose final result takes us to another higher level of understanding. However, from complex thinking, to articulate is not to put one thing next to the other, as postmodern praxis do (Ernesto Laclau, Donna Haraway, etc.). The activity of articulating consists in the superficial, tangential or simple proximity relations deepening and serve to create a true unity in diversity, which, being an open unit, enables a whole process of morphogenesis, i.e., of new emergencies of meaning.

If an element is never exhausted in the *ensidic*, as reported by Cornelius Castoriadis (2013); if an element is not an element in itself and for itself, as indicated by the Frankfurt school; if an element is not a static monad, as Morin pointed out… then, it is not prescribed in its "essence" what it can become. Every element has a *poetic*, creative dimension, which allows it to manifest novelty, invention and possibility. And it is this dimension that should promote education.

Therefore, dialectical and complex thinking must take up the phrase of Adorno (2002), "the whole is not truth" (p. 73), to reject any reading of reality that seems unification, coherence and integration in its elements. It must also recognize the transitory, quasi-schematic state of any idea. Although thought always longs to be made with a total and unparceled knowledge, this longing may be compatible with the recognition of the unfinished and incomplete of any knowledge. It could be said that the path of knowledge is for dialectical and complex thinking what for Paul Valéry was the elaboration of a poem: that which is not finished, but only abandoned.

Towards an Education to Protect Democracies

One of the fundamental concerns of any self-respecting education is to provide the best way of coexistence to its students. In this sense, any strategy that avoids educating in simplifying, reductive, and castrating schemes must be welcomed. Undoubtedly, the main challenge is to educate in and for the understanding of human complexity.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

Throughout this section a question will be raised that, although it seems simple, is more problematic than the ways that are usually offered to address it: ¿what is an "educated individual"? These are those kinds of questions that become more confusing as we move forward with their resolution.

To think about education involves thinking about many elements, articulating many levels, questioning many entrenched ideas that seem obvious. And to think about a dialectical and complex education, an education that converges different logics and paradigms, becomes even more complicated. If we seek to strengthen democracies, we must strengthen the capacity to think and live with plurality, and this is only possible by educating for difference.

At the expense of this, one can start from a clear premise: by nature, human beings are not democratic. We are not born "genetically programmed" to live in a democracy. Nor do we do it to live in tyranny. Human beings are born as a possibility of being many things and it depends on the "cultural genes" that are injected with us through education, we will be enabled to materialize some possibilities or others.

To talk about education—a purely human activity—we need to start from what constitutes us as humans: the word. It is the possibility of dialog, the capacity for reflexive communication—but not the uncritical transmission of information—that separates us from the rest of living beings. Only in nature and in cybernetic devices does communication come down to the transmission of data. The human being is the only living being that builds its world linguistically and semiotically, therefore, the way in which we approach these areas – the use of the word and communication – will outline the possibilities of the society in which we live, as well as the breadth of its diversity.

Our proposal is that an education that enables individual and emancipated life in a space always shared, is one of the many projects that can be built. Likewise, it is proposed that it is necessary to deactivate the exclusionary character of education to achieve this, since education serves both to respect and to undervalue, to create possibilities of freedom and to homogenize, to create projects that take us beyond determinism and immobility and to treat reality by objectifying and quantifying it.

Below, some strategies will be rescued so that education leads to a better coexistence, greater freedom and a real democracy. The basic framework for developing these possibilities is a political framework: it is a question of how to coexist in plurality *while keeping ourselves distinct and homogeneous*, a project that, without knowledge of that otherness that is

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

both me and you, cannot materialize. It is, therefore, about changing our way of knowing, our epistemology, in order to change our practice, our way of acting. All this based on a dialectical and complex thinking that allows individuals to converge multiple perspectives and levels within themselves. Let us recall the words of Adorno (2002): "Thought is, by its very nature, the denial of all concrete content, resistance to what is imposed on it" (p. 27).

This project requires a specific epistemology. Namely: the way we treat the other reflects a determined conception of reality and its identities, and it is not the same to treat these as something open, procedural and constantly changing as something closed, static and exclusive. It is not the same to think of reality with a logical framework as with a dialectical and complex framework. "Any policy must be based on a conception of man, society and history" (Morin, 2020, p. 11). Therefore, to think of the elements of reality in such a way that they can articulate their particularity at the antipodes of thinking them in an isolated and borderline way. We believe, therefore, that the main characteristic of an "educated citizen" is to possess a dialectical and complex thought that allows him to coexist with people different from him. Civility when it comes to seeking communication with the other and building something together will be the sign of their education.

Political management and its relationship with education

One of the characteristics of the political management of our current rulers is the absence of a sense of the multidimensional, as well as its possible mixtures and connections. Their thinking is one-dimensional, therefore ineffective: they decontextualize and distort what is in front of them because they do not understand it, and they do not understand it because a simplifying and reductionist *episteme* cannot understand what is complex and constantly evolving. The same is true of educational institutions: they are an example of one-dimensional, simplifying, and above all identitarian thinking, the latter being the most visible defect in contemporary politics and social discourse.

Between a person's mode of action and his or her thought structure is a bridge that is chiseled by the education he or she receives. It can be educated for freedom, autonomy, and coexistence in diversity, and it can be educated for rejecting patterns that are not ours. If we opt for the former, we will enable a society of citizens who will know how to manage shared values in a space of inclusion and belonging; in this case we would

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

be good heirs of the philosophers of Antiquity. If we opt for the second alternative, we will immerse ourselves in a society hostile to the unknown and the different, unable to communicate with what does not belong to its identity group, we will encourage barbarism and incivility, and we will perpetuate problems that should now be eradicated.

If building freedom in company is one of the many possibilities available to human beings, on the contrary, building "the fear of freedom"—to paraphrase Erich Fromm—is the most dehumanizing possibility of all. The "desirable" for a society that clearly continues to evolve and whose contexts are always uncertain should be an individual without fear of being free and autonomous, a strategist ready to take charge of his place in a world to become. This, on the other hand, is the least "productive" for a society that seeks the automation of its citizens to give free rein to market development. The most useful thing for the *polis*—as a public space under construction—is the most useless thing for the market, since the latter does not need citizens, but objectified consumers and objectifiers.

An educated citizen must have the resources not to be a mere consumer who neglects public space. The educated citizen, in a community among equals, must fulfill the idea that Aristotle (2001) formulated as the basis of his philosophical anthropology:

> Only man, among animals, possesses the word […]. The word exists to manifest the convenient and the harmful, as well as the just and the unjust. And this is what humans have in comparison with other animals: to possess, in an exclusive way, the sense of the good and the bad, the just and the unjust, and the other appreciations (p. 48).

It should not be forgotten that the Greek *logos* does not refer only to "word", but also to "reason", "language" and "dialog", i.e., the human being is the animal that not only speaks, but reasons in company, that *dia-loga*. What develops us as human beings is the exercise of language through dialog in community and with oneself, a community in which we should not prioritize who *is right*, but how we can better coexist *with reason*. We do not dialog to impose our own schemes: we dialog to abandon part of our ignorance through the exchange of ideas and arguments with others.

Politics is, above all, the way in which ethics can be embodied and materialized in the community, a community that is historical and therefore in continuous evolution, in constant creation. Education, in this sense, is always political, since we are unfinished beings that need to continue building not to finish, but to live and coexist. Education is the means by which ideas are inserted in the individual and therefore in society,

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

test each established context and materialize one way of (with) living or another. Dewey (2004) said that education "is that reconstruction or reorganization of experience which gives meaning to experience and which increases the ability to steer the course of subsequent experience" (p. 74). Education, therefore, is the laboratory of thought and, consequently, the preamble of action and also of democracy.

Educating in plurality: approaches from different thinkers

Education in plurality is necessary, on the one hand, because we live in the company of beings different from us, even when they are of our same culture, nationality or religion, and on the other, because we all need to live in a welcoming and non-hostile environment. The state cannot force anyone to study a career or develop certain personality traits, however, as far as public space is concerned, it can and should build an educational model that helps to know and exercise our obligations as citizens.

Bauman (2003, p. 27) said that it is necessary to learn to think in a liquid way in order to be vaccinated against the tendency to the solid, because as Norbert Elias (1990) indicated: "What individuals form one with another is not cement" (p. 27) and Octavio Paz (RTVE, 2014): "Double threat: turn us into air, turn us into stones". The great reform of education, then, lies not in imparting other content, but in teaching to think differently, as Freire (2023) pointed out: "Teaching is not transferring knowledge, but creating the possibilities for its own production or construction" (p. 79) and Morin (2016): "The vision of things depends less on the information received than on the way in which our way of thinking is structured" (p. 89).

Noam Chomsky (2013, p. 160) wrote in *The (de)education* that the ultimate goal of productivity achieved in contemporary times should not be the production of goods, but the production of human beings capable of associating with each other to create possibilities of development and evolution. This production would be the only one capable of establishing a free community, a community that is always being made and that is aware of it. In other words, it is a question of betting – again, always – on humanism and its transmission of values, of ideas that go beyond what they have in front of them, of multidimensional, flexible and tolerant perspectives. It is about betting on dialog and not on monolog. It is about betting on dialectical and complex thinking and not on logical and one-dimensional thinking.

Erasmus of Rotterdam (2007, p. 87) taught, even living in a century very different from ours, something very important: without dialog

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

there can be no freedom, but only imposition. In the beginning, Erasmus says, it is the *serm* (dialog) not the *verb* (imposition of the word/truth). In the beginning it must be dialog and not the word true, absolute, evident. Erasmus knew that only through the spoken word could the fire of fanaticism be put out. However, today we see that our epistemic unconscious remains "biblical": in the beginning it is the verb and the truth, and not the dialog.

A society of citizens educated to understand coexistence as a *sermo*—as a construction through dialog—is not the same as a society of servants obedient to the word, people who take as natural the slogans dictated by power. Citizens should be educated to think and decide for themselves, and not citizens to reduce themselves to the identities and truths transmitted; citizens who refuse to receive a life made, since, otherwise, they are reduced to being mass, as Ortega and Gasset foreshadowed (2013, p. 32). And the human being is not of the order of the mass, but is able to confront with power and propose new senses, which sometimes involves saying "no". A word that needs courage and philosophical strength.

For an individual to be able to say "no" he has had to receive an education that allows him to locate the moment when a logic, despite containing *internal logic*, is insufficient to approach reality, and therefore becomes pernicious for protecting the dignity of all. Since the time of Socrates, education—which for him was based on the method of mathematics—is postulated as the only one capable of making emerge a developed, cultured and able to think for himself.

The term "maieutics" comes from the Greek *maieutikós* and means "giving birth", referring to the process by which the mind of a student is guided to "give birth" ideas by itself and not assume them impostedly from outside. In mathematical education, the teacher acts as a facilitator of the learning process, asking questions and leading the student to discover the answers on his or her own. The student is considered an active agent of his own learning and not a passive recipient of information. If mathematical education is based on dialog, the search for truth and the constant questioning of preconceived ideas, at the opposite extreme is an education based on the passive transmission of information, the absence of critical reflection and the lack of dialog between the teacher and the student. This form of teaching is referred to by Freire (2023) as "banking education" (p. 91).

Banking education refers to a teaching model in which knowledge is considered as a deposit in the student's mind, reducing the role of the teacher to that of mere transactor and the student to that of resource or

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

instrument. In this model, students are not encouraged to question or challenge established ideas and reach conclusions for themselves, nor are they treated as active and autonomous subjects. We could define the difference between these two types of education with the following phrase, attributed to Socrates: "Education is the lighting of a flame, not the filling of a vessel" (Roger & Regalado, 2016, p. 84).

Hence, it is worth asking, once again, ¿what is education? Education is the ability to understand, in the least reductionist way possible, a world composed of innumerable levels. Levels ranging from the most rudimentary and material—wheels, pacifiers, bottles—to the most symbolic and immaterial—language, religions, thoughts. In this sense, simplifying, banking or one-dimensional thinking, in addition to distorting reality, is ineffective: it decontextualizes and distorts what is complex and constantly evolving, therefore, it prevents acting in a pertinent way. This type of thinking, as Herbert Marcuse (2016) pointed out, is limited to confirming a single perspective or dimension of reality without considering other levels, interpretations or relevant aspects. In this way, it creates a dissonance between what is being interpreted and the interpreter, since the bridges between them are not efficient: the interpreter only captures 1% of what is in front of him and is frustrated with the 99% that he does not understand. And this is precisely what happened in the COVID-19 pandemic, as we will see below.

The pandemic's lessons on one-dimensional thinking

The pandemic has shown that presenting society as a pile of uncertainties, mismatches, and insecurities is the greatest tool of radicalism, totalitarianism, and identity discourses. It can be easily seen how COVID-19 became an *ideological virus*: what was ideological is not the virus, but *what was done with the virus* at *the* sociopolitical level. During the pandemic, representatives of all fronts and ideologies decided to take the opportunity to blame the inability to contain the virus on some movement, present or past, undertaken by "the adversary." In this way, a global pandemic moved away from being a health battle and became a battle between identities and ideologies, a war in which, in the face of the virus, a disintegration began with the political, which is always the space for communication and coinvolvement. A crusade where biased, one-dimensional and dogmatic discourses have been presented as the only possible alternative to a reality that is "too" plural and chaotic.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

Far from treating the world as it demands to be treated, in a complex, multicausal and multidimensional way, citizens, exasperated by so many post-2008 crises, look at the world with an increasingly simplified and reductionist discourse that spreads through socialization channels and the media. This discourse ensures that the crises that plague the planet are the direct cause of concrete adversaries, and not a trait inherent in the neoliberal system itself. A system that, on the other hand, has nothing to do with the liberal concept of citizen: neoliberalism excludes the citizen from politics and reduces him to mere consumer/instrument.

At this point, the public space, the *polis*, has been torn apart in a struggle between private spaces, in a battle between radicalized and monolithic discourses that pretend to explain the whole reality through *a single logos*. Because of this, it is necessary an education in dialectical and complex thinking capable of subverting the gradual simplification —which translates spontaneously into radicalization— of the ability to think and act. The fanaticism to which one-dimensional thinking leads is no longer a challenge at the local level, but an obstacle to global coexistence. Therefore:

- Education should offer students a way to look away from the uncertainty, plurality, and otherness that they –and will always– pass through the world. The encouragement of dialectical and complex thinking should be the bridge to this goal.
- Politics must *do politics* again. This means that the public space, the *polis*, must insist on its essence of shared space, a place in which plurality is a fact from which it starts and not a possibility for debate.

Educational proposal

The proposal presented here aims to analyze the thinking of schooled adolescents living in democratic societies with the aim of understanding their relationship with public space, identity discourses and their fellow citizens. Taking up the studies of the Frankfurt school when they tried to clarify, in the pre- and post-Hitler context, the relationship between citizens and the submissive acceptance of radicalism (Adorno, 2006), we will propose two ways to prevent and intervene the radicalization of thought in young people: the elaboration of surveys aimed at analyzing the rise of anti-democratic populist currents, on the one hand, and the curricular

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

recovery of *deep culture*, on the other. A culture composed of complex works that the students, far from being able to assimilate instantly —as happens with the works of *mass culture*— must face with a different, active and emancipated look of the prevailing logic.

The polls, on the one hand, aim to unravel the bridge that unites the still current and massive support for democracy with the acceptance of thoughts that go against it, such as the appeal to democracy itself to demonstrate against political enemies, the search for the necessary "Jewish third party" in any closed narrative about itself: "Our society does not work because X is in it," or the attempt to cancel any action and thought considered contrary to the thoughts of the group itself. In this way, the surveys will try to trace the accepted and naturalized anti-democratic tendencies in democratic societies, revealing, through various questions, the anti-democratic potential of the ideas embedded in the thinking of young people. These surveys are composed of questions such as the ones below, although they can be expanded or specified differently depending on the context:

Indicate from 0 to 10 how much you agree with the following statements:

1. Obedience and respect for what the authority dictates are the basis for the proper functioning of any society.
2. What any country needs, more than laws and political programs, is a few brave, strong, and committed leaders that people can trust.
3. The national way of life is disappearing so rapidly that a strong educational program is needed that imposes with discipline and dignity.
4. The current democratic crisis is caused by the permissiveness of overly diverse views and tendencies.
5. Rather than democratic participation by all citizens, what is needed are a few technocrats who do not need public support to act on what they see as necessary within their fields.
6. The local self-employed shops cease their activity due to the arrival of foreign people who open their own shops.
7. The only way for Western culture to survive is to return to strong values that can compete with the strong values of other cultures.

These questions would go hand in hand with two additional, more informative, questions to learn the context of young people:

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

8. ¿What social class does it belong to (parents' educational level and job position)?
9. ¿What are your main sources of information (family, social media, books, newspapers, friends, etc.)?

Thus, the answers would be read through typological results ranging from the "radical inclination"—tough, moody, manipulative young people, who claim not to change for anything or for anyone—to the "non-radical inclination"—submissive, conformist, naive young people, open to change and permeability.

The aim of these surveys is to show that democracy is the only possible way in a world composed of different senses and ways of thinking. It is about showing the diversity that already exists, that has always existed and that will always exist. A diversity that is often omitted by entire families, but also by educational discourses that show one of the many faces that make up the subjects, especially the humanistic ones: colonialism, environmental development, racism, revolutions, oppressions, crusades, etc. Each of these meanings can be interpreted in antagonistic ways and lead to models of action which are also antagonistic.

The final stage of this pedagogical proposal focuses on rejecting any educational model that makes students closed citizens in their own paradigm, armored and uncritical citizens, and does so by putting young people before complex works, dilemmas and problems to which they must look with new eyes. Eyes that dispense with the one-dimensional logic that they have naturalized due to the populist messages that govern the sociocultural paradigm.

These complex works must move away from the works that govern the youth paradigm and come from the cultural industry, because although many contain positive values and show the diversity existing in society, they remain simplistic and encourage the gaze of young people to become partial and one-dimensional. Thus, cinema and literature would be the main ways to break with the paradigm of simplification, through examples such as the following:

In cinema:

- *Dreamers* (Bertolucci)
- *East of Eden* (Kazan)
- *Living Your Life* (Godard)
- *One sings, the other doesn't* (Varda)
- *Investigation into a citizen free from all suspicion* (Petri)
- *Hannah and her sisters* (Allen)

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

- *The Exterminating Angel* (Buñuel)
- *The Shout* (Skolimowski)

In literature:

- *A Happy World* (Huxley)
- *1984* (Orwell)
- *Fahrenheit 451* (Bradbury)
- *Of Mice and Men* (Steinbeck)
- *The Handmaid's Tale* (Atwood)
- *The Clockwork Orange* (Burgess)
- *Fictions* (Borges)
- *Frankenstein or the modern Prometheus* (Shelley)

The target? Complexify their understanding of the world, make them understand that not everything has a happy ending, put them before logics in friction and allow them to develop a strategic thinking that is suitable for uncertainty and change. It is about developing their capacity to detect what should not be perpetuated and to look for strategies to channel it. And all this to avoid that a new radicalism, born of a new radical way of thinking, has no place in our present and future societies.

An education for the protection of humanity

Adorno, in the middle of the 20th century, analyzed the barbarism committed by the Nazis in his essay "Culture and barbarism", written in 1949 and now present in the book *Critique of culture and society II* (2009). There he argued that European culture, which had produced great intellectual, technical, and artistic achievements, was the germ of the supremacist delusion that culminated in the gas chambers. This meant that the Enlightenment and the "progress of reason," while succeeding in perfecting human dominance over nature and developing technological and scientific tools that allowed us greater material well-being, had not led us to the moral and ethical progress that we might expect.

The reason for this derailment was clear: "instrumental reason," that focused on perfecting material goods through technical improvements, became destructive by not containing an ethical basis that delineated the direction of their inventions. Concentration camps and gas chambers, two of the greatest technical and logistical inventions of the 20th century, were its clearest examples.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

Adorno pointed out the importance of education showing the multitude of assumptions, prejudices and naturalizations that could lead to an environment of hatred and intolerance such as that which led to the Holocaust. Assumptions such as those outlined in the aforementioned survey ("Obedience and respect for what authority dictates form the basis for the proper functioning of any society; What any country needs, rather than laws and political programs, is a few brave, strong, and committed leaders on whom the people can place their trust") led—and could lead—to what Morin calls "barbarism."

From all this came a conclusion. The Holocaust imposed on education a new moral imperative: the duty that Auschwitz – as a concentration camp and as a symbolic dehumanization – never be repeated. Adorno argued that the Nazi delusion represented a fundamental break with the moral and ethical values pursued by Western civilization up to that time. It was a before and after in history, since all the advances of knowledge had been put at the service of extermination. Previously, atrocities committed by other eras and peoples had been, in a sense, more "naive," as the means available were more rudimentary. Auschwitz represented a gap in using the intellectual and scientific knowledge accumulated since the dawn of civilization to exterminate a part of humanity. This, according to Adorno, belied the memorable belief carried over from the time of classical Greek philosophy: that immorality was a consequence of lack of knowledge and that, with greater culture and education, greater tolerance and better ethical behavior. The *crux* of the matter was not, in the eyes of the German, to achieve *more education*, but to pursue *another education*, an education for humanistic purposes, an education that injected the democratic genes of which we spoke at the beginning of this dissertation.

Auschwitz became a landmark that challenged conceptions about the mission of education and its relationship to politics. For Adorno (2009), the scale and systematic nature of the genocide showed that an "educated" humanity—the Nazi commissars were mostly educated people—could also commit unimaginable acts of cruelty and dehumanization. In this context, the German concluded that a civilized education was one that directed scientific achievements to humanly desirable ends and, above all, to the protection of a maxim: that human dignity is above all ideas and discourses.

This new moral imperative, according to Adorno, required a critical review of existing social and educational structures, starting with their means and continuing with their objectives. The Auschwitz massacre, from their perspective, forced a rethinking of civilization's funda-

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

mental values and a deeper understanding of ethical responsibility in a world marked by the possibility of impersonal brutality in the age of new technologies. For all this, Auschwitz now teaches us two things: that material progress does not necessarily entail moral progress, and that achievements in knowledge require educated thought to guide them.

Conclusions

Education, if it is true to its mission, should avoid being reduced to a one-dimensional, banking or simplifying education. Education must provide a multireferential and multilevel understanding of what surrounds us. Knowledge, like the reality it seeks to grasp, has no borders. The borders are put by our *episteme* and it depends on this that something complex looks like this or, on the contrary, it looks extremely simplified.

It should be remembered that the objective of education is to build citizens, people capable of managing both personally and in the community. If education wants to develop dialectical and complex thinking in young people, it must undertake a holistic teaching that inevitably starts from the interrelationship between knowledge. In this way, education will not limit students to a single dimension of reality, but will promote a broad and deep understanding of the issues and problems that constantly emerge before them. As De la Barra (2019) indicates:

> The main objective of an educational approach is the integration between disciplines. This aims to achieve transdisciplinarity as the highest level of integration. This means that, through real problems, students apply knowledge and skills from two or more disciplines, which helps shape the learning experience.

And shaping the learning experience has been, since the time of Socrates and mathematics, the ultimate goal of education:

> There is a close relationship between transdisciplinarity and complexity, as both approaches advocate an integrative and contextualized view of knowledge. Transdisciplinarity provides an epistemological basis for dealing with complex problems from a broader and holistic perspective, while complexity offers a theoretical and philosophical framework for the transdisciplinary approach, highlighting the importance of recognizing and addressing interconnection, uncertainty, emergence and self-organization in reality (Moreno Guaicha *et al*., 2024, p. 89).

The mission of education is to strengthen the conditions of possibility of a world-society composed of active citizens and strategists, citi-

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

zens who are consciously and critically committed to the construction of a *civilized civilization*. Therefore, education has to stop being just a profession and become the political task in a mission of transmitting strategies for community life. This transmission needs as a basis what is not indicated in any manual, but Plato already pointed out as an indispensable condition of all teaching: *eros*, which is at the same time desire, pleasure and love for giving and receiving. In this way, we would like to conclude this work with a quote from Morin and another from Adorno that can shed light on the problem that has occupied us here:

> We must abandon the idea of a violent revolution that makes *tabula rasa* of the past and overthrows a bad society to find a good society. We propose a progressive path charted by a new policy rooted in the humanist culture of the past, and we vindicate the republican principles of Freedom, Equality and Fraternity. This complementarity entails antagonisms that a political thought must manage, giving alternating priority to each of these terms (Morin, 2020, pp. 72-73).

> I would say that the figure in which emancipation takes shape today is that people who believe it is necessary to walk in that direction influence in the most energetic way so that education is an education for contradiction and resistance. I think, for example, of the possibility of going to see commercial films with the last courses of the institutes and, perhaps also of the schools, then showing the students the kind of hoax with which they have had to face, the fallacy of all that. Or in the attempt to immunize them, in a similar sense, against certain morning programs, so common on the radio, where on Sundays first thing in the morning they are invited to listen to radiant music, as if we lived, as it is said so beautifully, in a "healthy world". Or a music teacher might analyze, showing them why such a song, or even a piece of the musical movement, is incomprehensibly worse, speaking in the most objective way, than a quartet of Mozart or Beethoven (Adorno, 1998, p. 125).

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Scientific Models as Abstract Epistemic Tools for Learning how to Reason

Los modelos científicos como herramientas epistémicas abstractas para aprender a razonar

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Abstract

The variety of scientific methodologies aimed at obtaining knowledge, generating beliefs, and promoting action is very wide. Both philosophy of science and science education have been concerned with critically assessing the virtues of the various scientific methods, especially the inductive and deductive ones. However, the emergence of new procedures specific to non-academic sciences has encouraged the development of new reflective perspectives that can analyze those virtues. From randomized controlled trials to epidemiological or clinical procedures, the Philosophy of Science has been concerned with examining the virtues and also the defects of their practical set-up. The article assumes that modeling based on empirical evidence is a practice of high interest in linguistics. In order to substantiate this assumption, two philosophical approaches to scientific modeling distinguished by their respective research lines on the notion of representation are compared: the Representational and the Pragmatic. These accounts are then illustrated with a brief case taken from linguistics called "language parsing", aimed at examining several particular samples collected as evidence in early stages of experimental modeling. By way of conclusion, it is emphasized that both philosophical accounts provide analytical elements that are relevant for the kind of scientific reasoning around models and whose scope in science education may be of great practical interest.

Keywords

Scientific Modeling, Representation, Language, Education, Pragmatics, Epistemic Tool.

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Index h: 5

Resumen

La variedad de metodologías científicas dedicadas a obtener conocimiento, generar creencias y motivar la acción es amplia. La filosofía de la ciencia y de la educación ha valorado críticamente las virtudes de los diversos métodos científicos, en especial de los inductivos y deductivos. Sin embargo, la aparición de nuevos procedimientos vinculados a ciencias no académicas ha promovido el desarrollo de nuevas perspectivas reflexivas que analicen dichas virtudes. Desde los métodos controlados aleatorios hasta los procedimientos epidemiológicos o clínicos, la filosofía ha examinado las virtudes y también los defectos de su puesta en práctica. El presente artículo asume que la modelación basada en evidencias empíricas es una práctica de alto interés en lingüística. Con el fin de sustanciar tal asunción, se comparan dos enfoques filosóficos de la modelación científica distinguidos por sus respectivas líneas de investigación en torno a la noción de representación: el representacional y el pragmático. Los enfoques se ilustran posteriormente con un caso de la lingüística denominado "análisis sintáctico del lenguaje", dirigido a examinar muestras particulares recogidas como evidencias en fases iniciales de la modelación experimental. Como conclusión, se enfatiza que ambos enfoques filosóficos aportan elementos analíticos realmente pertinentes para el tipo de razonamiento científico que pivota en torno a modelos y cuyo alcance en la enseñanza de las ciencias puede resultar de gran interés práctico.

Palabras clave

Modelación científica, representación, lenguaje, educación, pragmática, herramienta epistémica.

Introduction

The methodological diversity in the epistemic and educational fields is a fact that philosophy, especially the philosophy of science, has analyzed during the last decades. The inductive method, always important in everyday life and in the not so theoretically advanced phases of empirical science, presents some inability to create new and not purely empirical concepts (Bunge, 1963, p. 141). Deductive and abductive alternatives have become key ingredients to understand the types of argumentations in epistemology and in educational settings, but they involve their own weaknesses. All these proposals are participants in the new methods and procedures for obtaining and creating beliefs and knowledge, since, as is well known, induction is used when formulating certain hypotheses—formal or factual—in science and when validating factual theories. As Bunge pointed out (1963, p. 149), the mere mention of statistical inference should suffice.[1]

The epistemic procedures updated to the new scientific and technological needs are, as we said, diverse. In medicine (Sackett *et al.*, 1996), pharmacology, nutrition (Bengoetxea & Todt, 2021) or education (Cartwright, 2015; Cartwright & Hardy, 2012), as well as in almost all regulatory sciences, it is common to resort to evidence-based procedures that employ formal tools of inference. They have their own methodological hierarchies (organized according to their reliability and other epistemic

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values) and their preferred norms. A crucial procedure is the so-called "randomized controlled trial" or "clinical trial" (RCT), initially rooted in experimentation in medicine and pharmacology, but extended to other fields. In such a characterized context, it is important to distinguish the *most traditional or academic sciences*, in which the conditions of study and knowledge are closer to experimental laboratory standards, from *decision-oriented sciences*, sometimes called "regulatory sciences" (Bengoetxea & Todt, 2021, p. 43). Both areas are basic to obtain knowledge, project beliefs and motivate actions that, at least, can be characterized as reasonable.[2] The methodology aimed at obtaining knowledge in science, as we pointed out, is not only inductive, although this is common in empirical science. Influencing this in the classroom seems to be a crucial pedagogical aspect in an era in which unfounded skepticism and various "negationisms" advance at will, as, for example, Adrian Bardon (2020) rightly shows through his study of "motivated reasoning" linked to the beliefs and attitudes of "denial".

By contrast, the idealized experimental configuration of RCTs does not seem to be a sufficient basis for making definitive regulatory decisions. Some procedural shortcomings have already been detected (Trusswell, 2001), as well as a strongly reductionist bias that insists on the primacy of RCT experimentation as an ideal applicable to all areas of research. This generates a practical problem (many RCTs are not viable) that forces us to suggest methodological alternatives applicable to other areas of knowledge. A direct objective of this text is to show a methodological procedure related to modeling and reasoning operations, especially in the field of linguistics. For its possible elucidation, we propose to analyze it in order to understand the generation of knowledge and certain forms of reasoning in this field of the human sciences. We will call it "modeling-based reasoning." Models, also scientific ones, can have diverse types (material, abstract, scale, analog, etc.). In this text, we start from a general notion, according to which a model is the tool built by scientists with which the theory (its laws, principles, concepts) is put in contact (through mediation and interaction) with the empirical field of which it deals, in order to act on it or learn from it representationally. Underlying this, first and foremost, is the mediating notion of modeling found in Morgan and Morrison (1999) and in the proposals of Nancy Cartwright (2022). This idea of reasoning in terms of modeling will require confronting and analyzing two fundamental epistemological conceptions in current debates, within the empirical disciplines, research in the teaching of science and philosophy: the *representational* and the *pragmatic*.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

Experimental modeling in the study of language is an activity of enormous relevance as language is influenced by various cognitive functions with a crucial value for education and teaching, from memory and perception to the control and monitoring of the subject and its actions. We have witnessed for decades an unprecedented advance in scientific hypotheses about linguistic methodology (McKinley & Rose, 2020), so that, from epistemology and the philosophy of science, it is urgent to examine this type of hypothesis from a naturalistic and pragmatic approach (Schulz, 2014), beyond conjecturing hypotheses intuitively (McMullin, 2014). Scientific modeling is therefore the crucial issue underlying the text. In particular, it is the general modeling elaborated in the disciplines that deal with the study of language but focused from a pragmatic perspective that makes it possible to conceive the models as epistemic tools generated in experimental practices and whose objective partly aims at improving the learning procedures in the classrooms or in the manuals. Both the understanding of material content (scientific, linguistic) and the learning of better methods and practices of reasoning constitute an essential undertaking that students, teachers and researchers should develop if science teaching is really a fundamental objective of regulated education.

In this sense, it is necessary to understand that scientific-linguistic practice is both empirical and conceptual (Bunge, 1984, p. 163). This makes it interesting to investigate whether or not the data and experimental evidence of language acquisition, understanding and production contribute in any way to modeling and its working hypotheses (Baggio *et al*., 2012; Glymour, 2000). The present method, therefore, will consist in the use of certain advances of the own empirical linguistics in order to propose two philosophical concepts (modeling and representation) within a framework in which to examine real scientific practices,[3] not merely idealized prototypes that, supposedly, would have to "respect" certain normative codes of the own philosophy. The study of these concepts, based on bibliographic references linked to them, has the ultimate objective to show the validity, importance and reality of cientific models to help teach and educate in classrooms, seminars and laboratories.

The text is structured into five sections, including this introduction (sec. 1). In Sec. 2 we emphasize the importance of the study of modeling in evidence-based linguistics (LBE, hereinafter), of an empirical and experimental nature at times. Sec. 3 is devoted to countering two fundamental philosophical approaches to scientific modeling distinguished by their corresponding treatments and uses of the notion of representation: representational and pragmatic. We present as an application a brief case of linguis-

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tics ("syntactic analysis of language") aimed at examining modeling with evidence and using representational tools (sec. 4). The conclusion emphasizes the interest of the two previously developed philosophical approaches to model-based scientific reasoning and to science teaching (sec. 5).

Data and evidence versus intuitions in linguistics

Since the middle of the 20th century, generative grammar and formal semantics began to point to a risky aspect of linguistic competence theories: these appeared surrounded by a protective belt against the data provided by certain empirical disciplines (neuroscience, experimental psychology) (Baggio *et al*., 2012; Derwing, 1979). Generative linguistics was supposed to deal primarily with a specific model of real speech—the more general model (language)—that did not address the particular (physiological and social) circumstances of specific linguistic actions or their "complexity" (Bunge, 1984, p. 165). Today we know that this is not entirely correct or advisable. Chomsky did not oppose this objection and what he and other generativists did in fact was to clarify and defend that it is the syntactic component (opposite, for example, to the pragmatic one) that sheds more and better light on the characteristics of what they termed "language faculty" (Chomsky & Miller, 1963).

This does not concern the philosophy of linguistics. What happens is that the tension that has always motivated and strengthened this idea of generative grammar may be somewhat problematic insofar as it has relatively inhibited the advancement of experimental linguistics. Since linguistics is intended to account for conceptualized competence based on performance (*performance*) information – i.e., through standardized records of linguistic behavior – the Chomskians accepted that such data were indeed relevant to theoretical linguistic activity. However, the important thing was to find out from what kind of action the empirical basis of "competition theories" could be derived (Baggio *et al*., 2012, p. 328).

Under the generativist prism, the evidence base of linguistics would be that formed basically by introspective judgments. It seemed that Chomskian approaches rejected the speaker's own intuitions and demanded performative information with the aim of imposing certain constraints on competition theory (Baggio *et al*., 2012). The question about the empirical basis of competition theories remained on hold, however: ¿how should we obtain information about a speaker-listener's competence? According to Chomsky (1976, p. 20), we would obtain it by virtue of the

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

linguistic performance and introspection of a native speaker or a native linguist. These would be the means that would provide the linguist with the data with which to show the adequacy of the hypothesis about the linguistic structure underlying the faculty of language.

It seems clear that the generativists did not take into consideration the data obtained by controlled (experimental) observation and statistical inference. According to them, these methodologies were ineffective for the purposes of a theory of linguistic competence. Definitely, the types of data that could influence such a theory were reduced to *insightful intuitions* of the linguist.[4] Supposedly, experimental research sought to reach evidence that ultimately referred to *introspective data*. Therefore, they argued that linguistic theory was based on the intuitions of native speakers (Baggio *et al*., 2012, p. 331).

Linguistics does not model or perform experiments of the same type or design as those of the natural sciences (in general terms), but this is not necessary for it either. In the cases of Ilse Lehiste's phonology (Bunge, 1984, p. 167), psycholinguistics (Prideaux, 1979), multivariate comparative studies (Fine *et al*., 2011) or the field of complex networks (Bengoetxea, 2024), no attempt is made to evaluate an alleged ideal nature of experimentation or modeling (Radder, 2003). Rather, it is assumed that the genuine basic feature of these two activities is the modification of variables (modifying the tone and speed of speech, for example, to see if understanding depends critically on any of the changes made) and their comparison with control groups (Bunge, 1984; De Regt, 2017; Knuuttila & Merz, 2009). That is, it is an experimental modeling activity.

From this perspective, the emerging question is this: does LBE provide anything to our understanding of scientific modeling? Does linguistics contribute anything to the general scheme of science and to the scientific philosophical and educational fields? The philosophy of science accepts that linguistics sometimes does contribute to a better understanding of scientific modeling, albeit with a non-negligible nuance: the philosophy of science continues to consider that the immaturity of linguistics—due to its lack of laws and a supposed lack of explanations (Egré, 2015) 'is what places it in the background when compared to the natural sciences. But requiring the management of one's own laws and an offer of explanations is a criterion inherited from an overly positivist, if not controversial, view of science. The notion of law could be understood in terms of Hume's philosophy, as regularity (a systematic pattern) and thus as a possible pathway to an establishment of (probabilistic) laws in linguistics. Moreover, until not so long ago the notion of explanation in philosophy had received a

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

fairly biased treatment in favor of the natural sciences (Bengoetxea, 2023). Therefore, we suggest focussing aspects of linguistics that project a manageable and alternative image to that of the natural sciences with the aim of better understanding how it can be reasoned through the use of integrated models in real practices of linguistics. As has been pointed out, modeling and representation are two crucial notions here, the latter being the origin of the theoretical bifurcation between pragmatic currents, closer to the empirical disciplines, and the more ontological and epistemological ones, closer to properly philosophical activities.

Modeling and representation for reasoning in science

A model can be built in many ways. The model is not a copy of the phenomenon under examination or description, but an abstraction, more or less elevated, of it. A model of Ecuadorian Spanish speakers is not made up of all speakers. Models are incomplete because they are idealized. Some consider them "falsehoods" (Bokulich, 2012) or only "partial" truths (Bueno & French, 2018). This feature of the models has motivated several philosophical questions about their epistemic virtues, such as their reliability, their replication capacity and their validity (Magnani & Bertolotti, 2017; Abbuhl *et al*., 2013, p. 116). Beyond these interesting virtues, here we will deal solely with the possibilities opened by considering the instrumental nature versus the purely representational nature of modeling in scientific and educational practices, as well as in philosophy.

What usually serves as a model of an empirical domain (a *phenomenon or target system*) is a system constructed by abstractions, idealizations, analogies or computational simulations. The phenomenon or target system may be something existing or not empirically, since it may be fictional or simulated.[5] And if it exists, it may in turn be something constructed—for example, by technologies—without needing to be a fact of a natural genre (Bird, 1998). In any case, the construction of the model of the phenomenon will go through at least two distinct phases (Weisberg, 2013; Bailer-Jones, 2009; Bokulich, 2012; Bokulich, 2017; Bueno & French, 2018):

1. *Modeling is carried out through a specific constructive process*. Scientists seek to access the world's empirical systems in a way that enables them to generate reasoning and gain knowledge (or beliefs for action). Specificity is crucial here. This is achieved because the models are constituted in a constrained way to provide us with knowledge aimed at studying

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

or examining issues (or hypotheses) of interest. It is in this sense that it can be said that models are tools aimed at reasoning, artificial systems, built and constrained, oriented to answer fundamental questions of research.

This image of models is pragmatic and does not insist on the representation of a target system or empirical phenomena external to the model, since models are not conceived as separate entities that have to be connected to the systems of phenomena of the world through a representation relationship. In this sense, they already appear immersed in our knowledge of the world. Therefore, it is important to emphasize that the very construction of a model can facilitate (by analogy or by some other relationship between the structure of that model under construction and the phenomena of the real world studied) the examination that is made of the different elements (and the possible relations and functions established between them) postulated or given in an experimental configuration.

Constriction is crucial and is related to idealization in modeling. Without idealization, some empirical systems would be mathematically or computationally intractable –social phenomena are complex systems with many variables, for example– (Thagard, 1993) and could not be designed in order to isolate certain relevant or differential traits from the target system by rejecting the rest (Mäki, 2011). In linguistics, populations of speakers are ideally treated because not all the properties of a population are susceptible to be taken into account. For example, when working with speech samples, linguists do not attend to all the syntactic relationships between words (Buchstaller & Khattab, 2013). Researchers select a scientifically important subset of the properties of a studied phenomenon, and this will constitute the target system.[6]

However, the regulation of the types of permissible idealizations is not a simple matter (Weisberg, 2013). To avoid arbitrariness, general principles (in reality, constraints) adapted to the empirical work of the discipline are proposed. These principles guide a continuous and dynamic process of gradual tuning in the modeling process (Zielińska, 2007), which is partially sustained through already established resources (theoretical, empirical, mathematical, computational, and representational) and is the result of the triangulation of different media: other models, experiments, observations, background theories.

2. *From a theoretical perspective, it is argued that the model must have representational capacity*. There are two ways to understand this ability. The most philosophical (representational approach) conceives it as a *general fit* between model and target system. The target system has been sketched or designed (a population sample, for example)[7] with a series

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

of selected elements and with some question and hypothesis at hand in the experimental configuration. A potential difficulty of this procedure lies in the fact that, *although the target empirical system is an abstracted entity, the properties of the system are actually concrete—as is the case with corpus* samples of speakers (Stubbs, 2006). If modelers employ mathematical and/or computational tools, it is important to know if the model can be compared in any way with its target. ¿Can any analogy or similarity be drawn? (Eco 1995, p. 59). The standard way to respond to this is to reconstruct the phenomenon itself in formal (mathematical, computational) terms and then compare it with the empirical model, i.e., two models are confronted to detect some possible mutual resemblance (or an isomorphism, a partial homomorphism, etc.). In this way, a computational model, for example, will also adopt a certain material (in a computer), autonomous and concrete nature (Hausser, 2006). Model and target will be distinguished by the modeler by freely choosing the structure of the formal (or computational) model, while the target system is a constrained entity belonging to the world.[8]

The other way to understand representational capacity is pragmatic. Modeling is a process of interaction with the *representational tools* available to scientists. The model is designed with a purpose and serves as an artificial epistemic tool. It is common for the scientist—linguist—to have no interest whatsoever in a realistic description of any system of speakers, but simply to prefer to examine a series of interactions between elements and causes internal to the model itself.

Among the representational tools are in mathematics the differential calculus, graphs, networks, or diagrams, and in computing certain computer programs. The author has developed this question, applied to the study of language, elsewhere (Bengoetxea, 2023); there he specified the use of resources and representational tools in the modeling work of experimental linguists, for example, before the question of how the development of language can be compared in children without linguistic problems detected and children with some syndrome (Down, Williams), experimental modeling and the use of representational tools included corpus collected from the CHILDES database (http://childes.psy.cmu.edu/), transcribed conversations of three subcorpus of language (German, Dutch and Spanish), the SAN tool (high-speed local network formed by storage devices) to solve outstanding problems in previous modeling that combined scripts materials with software, the Netlang software —an integration platform that operates as a service to streamline the application connection process (www.netlang.com)— to collect data and evidence from speech sampling,

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

and in order to computationally model the experiment, the Cytoscape network software (Shannon et *al., 2003) thanks to which the data collected in various phases of experimental modeling are processed.*

This case serves to illustrate the fact that conceiving models as tools can be highly recommended for the teaching of science and reasoning with models. Models can be tools that motivate students to reflect on existing phenomena, but also on new phenomena, rather than understanding them as literal projections of what an empirical phenomenon actually looks like. In this way, it would even promote the construction of multiple models of mutually related phenomena with the objective of solving problems that the professor initially raised around some theory, previous knowledge and working hypotheses (Reith and Nehring, 2020).[9]

Formal representation and pragmatic representation

The previous sections allow to establish the state of the philosophical question around scientific modeling on the basis of a current debate: either the models are used as tools aimed at reasoning and solving practical problems that arise in a scientific context, or they are used for more philosophical and ontological purposes in search of some reality that the models supposedly represent. To discredit either option, which is often done, would in fact constitute denying the very value of the discipline that would perform the analysis of such a shaping task.

In the philosophy of science, these two general ways of interpreting representation (Contessa, 2011) have adopted a formal register, whose objective has been to identify and elucidate the nature of scientific models (syntactic conception and semantic conception) (Chakravartty, 2010), and a pragmatic one, according to which the roles that models play in real scientific practices and reasoning (generation of beliefs and knowledge, puzzle solving) must be examined.[10] Both registers have employed real-case studies. For example (Bueno,2014; Bueno & French, 2018) project modeling using a *partial structures* approach, while Suárez (2015) proposes an *inferential conception* in which the models built are machines that produce inferences. However, from a pragmatic perspective, these proposals have been criticized by not sufficiently emphasize that analyzing the process of model construction and manipulation—as we have already mentioned—is an indispensable requirement to study modeling oriented to gain knowledge and reason.[11] As Knuuttila and Voutilainen (2003) point out:

> While proponents of semantic conception seek to represent models of science as relatively stable and prefabricated entities, proponents of

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

> practice-oriented conception are interested in the modeling process and explaining why and how models are employed in scientific work (p. S 1485) (own translation).

The pragmatist alternative of Knuuttila (2006) presents a case of modeling as opposed to merely representational and serves to illustrate the idea of models as tools to study language. It is the "syntactic analysis of language".[12] Knuuttila proposes to conceive models as epistemic tools that highlight the material and instrumental role (tools) of models. This way of conceiving models seeks to identify how they are constructed, used and "imagined" in the various scientific activities—among them, those dedicated to teaching how science is done—since the variety of models existing in the sciences is very wide. In this sense, Knuuttila's appreciation is correct that the attempt by the philosophy of science (syntactic and semantic conceptions, first and foremost) to provide a general theory of representation based on modeling is a titanic and unrealistic undertaking.[13] Compatibilizing this desire with a naturalized and pragmatic project would be more advisable.

The idea of a model construction (which is the basis of reasoning) is crucial here because the dynamic and continued notion of a model in scientific practice was barely considered in the philosophy of science of the 20th century (Rost & Knuuttila, 2022). Models are not stable, stopped entities, which only act as mediators (still) between a formal and an empirical construct (Morgan & Morrison, 1999). The problem is that models of science are more complex than what Morgan and Morrison admit, which is partly because the phenomena they represent are complex entities as well. The former are not formed solely by theory, data and empirical evidence, but also by analogies, metaphors, theoretical notions, mathematical concepts, formal techniques and other pragmatic elements (Boumans, 1999), i.e., triangulation of the modeling task is a complex and arduous undertaking. Therefore, beyond the most common image of the modeler as a theoretical agent, we could project the image of the researcher as an enriched agent with characteristics more typical of the "know-how" (Stanley, 2011), such as skills and experience or expertise.

This new conception of modeling and the modeling agent makes us see with good eyes the productive and dynamic approach of models understood as "epistemic artifacts" (Knuuttila & Merz, 2009), although without approving the rejection of any notion of substantial philosophical representation that pragmatists profess. It is convenient not to conceive modeling as an activity that passively represents, it is true, but the philosophy of science will always have the right to defend a space for deeper

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

reflection about the nature of the models. This, of course, is not very useful in terms of understanding actual practices or educational approaches to the sciences. Hence, we separate the two objectives. From a practical perspective, we insist and accept that modeling is a substantial part of a process of understanding and knowledge of epistemic procedures that interest scientists (linguists, chemists, physicists, economists), since the practice of creating models and using them can help to understand more deeply those same practices (Svetlova, 2015). In this sense, to affirm that models are epistemic artifacts is equivalent to saying that they are concrete things that have their own way of functioning, without the need to represent (ontologically) any target empirical structure, no empirical phenomenon (Baird, 2004). In short, they are "concrete models" (Knuuttila & Merz, 2009, p. 150). This fits well with the idea of modeling processes in terms of tools located within experimentally designed assemblies (Rouse, 2015) or "social aggregates" (Latour, 2008, p. 57).

Modeling tools around language

From a close perspective to the pragmatic approach outlined above (Knuuttila, 2021; Rost & Knuuttila, 2022), it can be suggested that in modeling the supposed distinction between representing and producing without the need for a fit between model and target phenomenon becomes blurred (Boon & Knuuttila, 2009). Work with computational models, for example, is a partially virtual work in which substitutes (*surrogates*) are employed whereby researchers have the option to reason and construct inferences. Even if the representational value of modeling had been re-examined in pragmatic terms (Bailer-Jones, 2009; French, 2013; Giere, 2004), thereby improving previous models of representation *per se* (naive realist notion) (Hughes, 2010; Teller, 2001), this "mixed" perspective would still not sufficiently estimate the great importance of the productive (creative), practical and dynamic aspects of modeling and the reasoning generated by it (Humphreys, 2004), aimed at acting and gaining knowledge (Knuuttila & Loettgers, 201 2). This aspect must be taken into account because it is key to teach students to reason and to produce inferences with models to answer questions posed by initial hypotheses linked to the theories handled.

This can be clearly seen in the case of computational models, especially when designing and applying simulations. The approaches, idealizations and even the "falsifications" of modeling are linked to certain

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

constraints and *affordances* applied to a material and concrete object: the computer (Zuidema & de Boer, 2013). The representation genre implemented in computational modeling can be seen, first and foremost, in the modeling results and not so much in the passive structure of the models that supposedly reflect the structure of the empirical phenomenon studied (Rost & Knuuttila, 2022). In the case of syntactic analysis of language, the criterion for their valuation is more pragmatic than representationalist, since the linguist and the computational programmer represent completely different things, despite being constructing the same. The linguist seeks to represent the world as faithfully as possible; the programmer instead values the program-analyzer (*parser*) for what it produces (Knuuttila, 2006, p. 42). Consequently, it seems appropriate to argue that prefabricated, prefinished models that supposedly represent (*stand for*) phenomena do not configure the concept of model or modeling more interesting in the processes of modeling production aimed at generating reasoning, beliefs-knowledge, and actions.

Parsing by artifact modeling

Syntactic analysis is a linguistic procedure that has received open samples of theoretical interest in the philosophy of scientific modeling. From a philosophy that looks at scientific practices and not ideal prototypes of science, Knuuttila (2006) has dedicated himself to analyze the computational-experimental task surrounding the technological construction of models of syntactic analysis (Karlsson *et al*., 1995). It can be suggested, therefore, that this line of research is highly interesting to understand some reasoning practices and generation of linguistic knowledge aimed at teaching in science.

Syntactic analysis (*parsing*) is a grammatical procedure of describing words or sentences, or parts of a speech made up of words with their own shared grammatical features (nouns, verbs, adverbs, adjectives, conjunctions, etc.). This type of analysis automatically assigns a morphological and syntactic structure—without a semantic interpretation—to input texts of varying length and complexity (Knuuttila, 2006, p. 43; Karlsson *et al*., 1995). It is, therefore, a techno-linguistic device or program aimed at producing a syntactically analyzed text, and serves as an illustration to see how the construction of models can help both to scientifically understand the phenomena studied and to produce useful results.

There are two general approaches to parsing: on the one hand, the grammar-based approach, of a linguistic and descriptive nature; on the

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

other, the data-driven approach, of a statistical and probabilistic nature, which includes *corpus*-based learning rules, hidden Markov models and machine learning conceptions (Knuuttila & Merz, 2009, p. 160). The particular case of "Constriction Grammar Analysis" (CGP) —well developed in the philosophy of modeling in linguistics—combines a grammatical basis with the handling of experimental features, and is grounded in linguistic *corpus*. It remains completely at the level of the surface structure and, instead of stipulating rules for well-formed expressions (as the universal Chomskian generative grammar did during its early years), it is constituted according to constrictions that reject inappropriate sentences (Knuuttila, 2006, p. 43). However, syntactic analysis does not realistically describe or "represent" human language competence, nor does it pretend to. The scientific understanding it provides does not derive from a supposed "real" image of an empirical system, but rather is something dynamic and inherent to the linguist's expertise in the process of model construction—expertise with the handling and knowledge of language, cognitive elements, and the "technological artifacts" employed in practice—(Knuuttila & Merz, 2009, p. 159).

Syntactic analysis aims to computationally model some aspect of the language using a tool consisting of a computer program. Constriction grammar is a formalism of syntactic analysis that provides a correct grammatical interpretation of each word in a functional text, as well as enriching each word with additional syntactic information. In this way, the CGP is based on a previous methodological analysis carried out using a morphological and synthetic analyzer (Knuuttila, 2006, p. 43; Knuuttila & Merz, 2009, p. 160).

The words normally used by speakers are such that their shape (e.g. "square") is interpreted differently depending on the context of their use, i.e., many words are ambiguous. The CGP then seeks to select which of the interpretations is appropriate in the context of lexical occurrence, usually in a text or in a spoken discourse. This is called "disambiguation" (DeRose 1988; Knuuttila 2006, p. 44). This search for some interpretation is one of the most interesting ways to model language and to obtain relatively satisfactory and world-adjustable results (Eco, 1995).

A CGP proceeds in three stages (Knuuttila, 2006), in which what is expressed as "interpretation" can be translated into "modeling" in our most philosophical lexicon:

- Once the morphological analyzer has provided all the admissible morphological interpretations, the CGP checks which ones are

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

appropriate. It does this by applying morphological constraints that take advantage of contextual knowledge or *neighborliness of each word*. For example, if a word has a substantive and a verbal interpretation, and if it is preceded by an article, the relevant constraints subtract the verbal interpretations about that word.

- Once the character of morphologically ambiguous words has been elucidated, it is time to analyze them superficially and syntactically. The result of the morphological disambiguation module becomes *input* for the following module: namely, it will be a syntactic mapping. It will assign all possible surface syntactic functions to each accepted morphological interpretation. Again, the shape of a word can have different syntactic functions (subject, object or direct complement, indirect object or complement, etc.), so that in order to grant each word its correct syntactic interpretation, the linguist will apply syntactic constraints after mapping and discard assignments to contextually incorrect or illegitimate syntactic functions.
- The final stage is a direct consequence of CGP namely, it is a text in which, in the best of scenarios, each word will be assigned with its corresponding correct morphological interpretation and appropriate syntactic function.

Two crucial tasks here are how to represent "rule sets" of language (Knuuttila, 2006, p. 45; Karlsson *et al*., 1995) and the implementation of grammar as a computer program. This challenge is very delicate, since the linguist generates the models with the objective of describing the world and computing attempts to produce it, build it and modify it in a dynamic and interventionist way (Knuuttila, 2006; Hacking, 1983, p. 220). This model construction is a continuous process of modeling involving distinct (representational) layers and replicated checks of various *corpus* (Knuuttila, 2006, p. 45). Three necessary steps of this type of active and productive modeling that employs representational tools are the following:

- The writing of the CG grammar for a *corpus*. It is based on a morphologically analyzed text, for which the constraints that disambiguate the words are established.
- After applying the resulting grammar to a manually disambiguated *corpus* (linguist's empirical task), the system *software* generates an applicative statistic for each of the constrictions.
- From this statistic and after identifying the wrong predictions, the linguist (grammarian) either corrects and, or, dismisses

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

> previous constrictions, or creates new ones. This cycle is repeated by using the evidence of new *corpus* until the grammar is close enough to the "human action" (Knuuttila & Merz, 2009, pp. 160).

As seen, the construction of a syntactic analysis of this type opens an interesting way to the notions of modeling and representation, which move away from the traditional and static idea of the philosophy of science, rather occupied with the relationship between a type of prefabricated model and a real target system. According to this type of philosophy of science and epistemology, a model is epistemically useful if it provides a broad picture of the object or phenomenon studied. But if an approach is adopted, if possible, closer to the productive and pragmatic idea of Knuttila—and even if the syntactic analysis is the result of certain uses of representational tools—such an approach will be valued basically by what it produces according to what the agents have proposed (questions), and not according to the ontological reflection of a postulated reality.

Reasoning, believing and knowing through models to educate in science

It is convenient to analytically nuance the function of the modeling company. On the one hand, it should be noted that in scientific research models are conceived without the need for ontological assignments, i.e., as epistemic tools aimed at solving problems. It is the most radically pragmatic form. In the educational field of science, it would also be useful to project the pragmatic nature of modeling so that students learn to reason with a view to their goals: answering practical scientific questions, solving puzzles, etc. However, it is also possible to leave a space for philosophical questions related to modeling, so that it is not so enigmatic, given the millennial Western philosophical tradition to ask about the nature of what is being modeled. Not allowing this would have a disastrous consequence for many philosophers in fields close to the philosophy of science, namely their expertise and lack of preparation in empirical activities in which they would often act as mere guests. The supposed role of sociologist, political scientist, policy expert, regulator, or pedagogue, which many philosophers take for granted on the pretext that purely philosophical questions do not concern a field like modeling, should – if we praise sincerity – send them into unemployment.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

Fox-Keller (2000), as well as Gouvea and Passmore (2017, p. 50), among others, distinguish two interesting interpretations: the "models of" and the "models for". They argue that "models of knowledge", located in an environment of substantive philosophical representation, are always accompanied by "models for learning" because scientific models are tools for understanding, explaining and predicting, and not only in research itself, but also in classroom teaching. They consider that "models of" are less able to support the epistemic agency of experimenters and students when doing science, since they tend to treat models as representations of what we already know, instead of acting as tools that are used to generate new knowledge and reasoning (Gouvea & Passmore, 2017).

But philosophical analysis of practices also has its *raison d'être*. It must be recognized that conceiving models as tools and artifacts built to reason and generate knowledge is not something that necessarily has to start from assuming that there has to be a direct representation of an empirical system. It may be the case, and it often is, that if a teacher wanted to present how scientific modeling works, surrogate reasoning based on a simplified correspondence between, say, molecules and a material model of balls and sticks, or between language and an inherently human faculty of language, would not add any value to the learning environment (the classroom or the laboratory) unless the teacher worked out that supposed correspondence much better. In such a case, the key to the exercise would be to understand the hypothetical and practical nature of the model. However, from a more philosophical and humanity view, the understanding and interpretation of the notion of representation can be a source of interesting questions for scientific and educational environments.

Conclusions

The text endeavored to set out the two poles of the debate and to respect to a certain extent the possibilities which each opens up. For this, it has been considered that the modeling work must start from issues of interest, previous theoretical knowledge, and empirical knowledge, as well as a collection of data and evidence that allow to construct successive models, continuously, of the (idealized) system chosen as an object of study. A philosophical examination of this practice aimed at reasoning and useful in scientific research and science teaching has allowed us to distinguish the concepts of modeling and representation, and project, within the current philosophical debate, two basic approaches, *representational* and

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

pragmatic, as well as their mutual connections. Finally, an outline of the application of the proposed reflections to the modeling study of language and to the case of syntactic analysis has been suggested. The final conclusion, therefore, intends to leave room for proper philosophical reflection, without undermining pragmatics, in which the various representational tools (symbolic, semiotic or material resources) also play an educational role with their own character.

Notes

1 There are several papers dedicated to the methodology of the sciences written from a philosophical and introductory perspective. I recommend the classic, original 1976, *What's That Thing Called Science?* by Alan F. Chalmers (1993) and the more novel and very enjoyable *A Philosopher Looks at Science*, by Nancy Cartwright (2022).

2 It should be noted that the use of empirical evidence is dictated, at least in part, by axiological considerations (pragmatic and epistemic, for example) in order to make decisions that may affect regulations in public policy, food, health (drugs) or—among other clearly important fields—education (Cartwright & Hardy, 2012).

3 These practices include activities related to research in science education. In this regard, some interesting references are Krell *et al.* (2020) and Matthews (2007).

4 Linguistic research thus advanced one of the most fashionable topics in the philosophy of science: the debate between intuitive (armchair) obtaining and experimental obtaining of data and evidence to generate reasoning (see Sytsma & Buckwalter, 2016).

5 About modeling without target phenomenon, see, for example, Weisberg (2013, pp. 129–131).

6 An example of this in linguistics is that of *corpus*, whose prototypical cases are those that pretend to be representative of a particular language, of a variety of this or of some of its records (Gries & Newman, 2013; Kepser & Reis, 2005).

7 It should be noted that the configuration and extension of a sample depends on the judgment, background knowledge and representational tools of the experimental linguist, but not so much on an automated statistical algorithm.

8 This is the underlying theme of the debate between Eco and Rorty (Eco, 1995) around interpretation. This, and modeling also, by analogy, may be a purely pragmatic activity, aimed at reasoning to solve practical (scientific) problems that have little to do with what is in the world (Rorty) or, instead, may depend on ontological and epistemological assumptions of a philosophical nature that are occasionally disparagingly labeled as "naive realists".

9 Although it is to criticize them for not properly characterizing the notion of representation, Rost and Knuuttila (2022) review some pragmatic representational proposals applied to the field of education, among them Cheng *et al.* (2019) (tools to explain the mechanisms underlying target systems), Stieff *et al.* (2016) (specific molecular models) and Oliva *et al.* (2015) (competence of high school students in modeling chemical transformations).

10 The distinction between analytical (substantive) and pragmatic approaches to representation —some call it in other ways: "informational-functional" (Chakravartty,

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 257-279.

2010) or "informational-deflationary" (Poznic, 2015)— establishes two research agendas that can be distinguished thanks to their relative hypothetical connection to the study of real scientific activities (Suárez, 2015). Analytical approaches seek to elucidate basic relationships between theory and the world, while pragmatists attempt to account for the scientific practice of model construction (Boon & Knuuttila, 2009; Bueno & French, 2018; Chakravartty, 2010; Suárez, 2015; van Fraassen, 2008; Weisberg, 2007).

11 Rost and Knuuttila (2022) criticize, one by one, each representationist-pragmatic proposal because none of these characterize or adequately define the notion of representation. Apparently, as we will argue in the last section, this serves them to disqualify the philosophical enterprise (representationalist, ontologistic, epistemological) that tries to give an answer to the question of the nature of knowledge through scientific modeling.

12 Knuuttila argues that models are epistemic artifacts (tools) created to meet or achieve certain specific goals and that they are made productive through human work and manipulation within particular scientific practices (Svetlova, 2015).

13 For a brief critical analysis of some fundamental aspects (as well as some puzzles) of the general theory of representation, see Frigg (2006, pp. 50–52).

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Academic Challenge using Writing Virtual Tools

El desafío de la escritura académica utilizando herramientas virtuales

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Index h:8

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Index h:7

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Index h:7

Resumen

Las tecnologías se insertan en la innovación educativa, dando la posibilidad de incorporar herramientas digitales en los abordajes investigativos. En este escenario Scrivener y Evernote son herramientas digitales para la escritura académica, permiten insertar notas escritas, notas de voz, resúmenes, documentos, imágenes, citas de autores, audios, *links*, entre otros. La formulación del problema parte de la necesidad de incrementar investigaciones en todos los niveles educativos de forma fácil y automatizada. El objetivo de este estudio es reflexionar sobre el aporte significativo que poseen las herramientas virtuales en la escritura académica. La metodología empleada está enmarcada dentro del paradigma cualitativo de tipo no experimental y documental, posee un muestreo probabilístico intencional de 57 fuentes documentales primarias que reúnen artículos científicos, libros, fuentes oficiales, informes técnicos, autores y organizaciones que respaldan las teorías de las herramientas digitales para sustentar de forma científica el artículo. La conclusión radica en que las herramientas Scrivener y Evernote generan un aporte significativo al desarrollo de la escritura académica, logrando contribuir al impulso de la publicación de artículos académicos y científicos que, asociados a las tecnologías de la información y comunicación, promueven el desarrollo de este tipo de comunidades investigativas, para lograr una mayor optimización de recursos intelectuales como un desafío para potenciar la cultura académica.

Palabras clave

Escritura académica, Evernote, herramientas de escritura, Scrivener, tecnologías.

Abstract

Technologies are inserted in educational innovation, giving the possibility of incorporating digital tools in research approaches. In this scenario, Scrivener and Evernote are digital tools for academic writing; they allow to insert written notes, voice notes, abstracts, documents, images, quotes from authors, audios, links, among others. The formulation of the problem is based on the need to increase research at all educational levels in an easy and automated way. The objective of this study is to reflect on the significant contribution that virtual tools have in academic writing. The methodology used is framed within the qualitative paradigm of a non-experimental and documentary type; it has an intentional probabilistic sampling of 57 primary documentary sources that consist of scientific articles, books, official sources, technical reports, authors and organizations that support the theories of the digital tools to scientifically support the article. The conclusion is that the Scrivener and Evernote tools generate a significant contribution to the development of academic writing, contributing to the promotion of the publication of academic and scientific articles, which associated with information and communication technologies promote the development of this type of research to achieve greater optimization of intellectual resources as a challenge to enhance academic culture.

Keywords

Academic Writing, Evernote, Writing Tools, Scrivener, Technologies.

Introduction

The challenge of academic writing using virtual tools makes it essential to incorporate virtual scenarios in the production of knowledge through writing. In this sense, this research wants to reflect on the significant contribution that virtual tools have to academic writing, since there is little generation of knowledge of teachers and students at the high school level

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and higher education. In this sense, new information and communication technologies (ICTs) provide numerous ways to strengthen writing processes. Valverde (2018), states that "digital spaces serve to involve students in tasks such as articles, research projects, essays, etc., in short, any academic work where students have to locate scientific-academic knowledge, analyze it and express it in writing" (pp. 5-6). It is therefore appropriate to harmonize technological tools for the production of new knowledge in a scientific way.

Academic writing is an important part in the generation of knowledge from the university and therefore:

> It is a dimension of the epistemic work and is part of the work of production and teaching of knowledge in university community spaces […] It includes a variety of textual classes with different cognitive-communicative function: essays, research projects, research reports, research articles, academic articles, academic reviews, presentations, thesis (Coronado López, 2021, p. 71).

In that sense, "tools like Scrivener and Evernote make writing easier" (Schcolnik, 2018, p. 30), which favors academic and professional environments for writing. Trigo (2013) highlights that Scrivener "tries to combine the efficiency and speed of the digital world with the flexibility and comfort that pencils and notebooks provide throughout life, something that until now had not achieved any text editor" (p. 2). In this perspective, "Scrivener is much more than most writing programs or a traditional word processor" (p. 25). Thus, with the use of the tools indicated, both teachers and students will be able to write taking advantage of the benefits of ICT, since, with the automation of quotes, abstracts, draft texts, etc., one can work from anywhere in the world and on any device: smartphones, Tablets, smart watches, computers, *laptops*, etc.

"Evernote is a notepad, which allows all kinds of information to be stored as personal annotations, […] it is an excellent resource for collecting, storing, categorizing, labeling, retrieving and sharing information with students and other researchers" (Universidad Católica de Valparaíso 2018, p. 23). In other words, it is a virtual tool that serves to organize information, so it is very versatile for writing texts through notes. In fact, Gaspar (2013) points out some important functions of the tool:

> Create notes from text, audio, voice and images, organize notes. On the other hand, it has other uses such as: searches with quick access to information, information sharing, creation and synchronization of notes on all devices, among others (p. 12).

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 307-327.

Therefore, it is a current and important topic, since digital tools for writing are increasing in terms of their use and serve to optimize written notes in a digital and automated way; they contribute to academic writing from virtual platforms that are easily accessible; they promote the creativity of writers, whether they are students or teachers; they enhance writing as a contribution to research from various scenarios such as the publication of texts, articles and essays, a perspective that modern education demands in the production of knowledge.

The work methodology used is a research framed within the qualitative paradigm, with non-experimental and documentary design, which uses documents to obtain the information. Sampling was intentional probabilistic of 57 primary documentary sources, consisting of scientific articles, books, official sources, technical reports, authors and organizations that support theories on the use of virtual tools in writing, collected from high-impact databases such as Scopus, Elsevier, Dialnet, Google Scholar.

The structure of the article begins with an explanation of what academic writing is. Next, what is academic writing in higher education is pointed out, highlighting the scientific benefits of publishing articles by teachers and students in scientific journals. Then, approaches to academic writing are presented with virtual tools such as Scrivener and Evernote, which constitute automated methodological processes for more effective and interactive writing. The following sub-topic tries to be framed in the use of technological tools that are found on the Internet such as: *blogs*, videos, websites, high impact research sites, digital books, virtual documents, etc., with the purpose of developing skills for writing in a digital way, mainly when saving notes related to bibliographic references in an agile and secure way. The article concludes with reflections on the academic benefits that the Scrivener and Evernote tools have for researchers; likewise, it reflects on the teacher's vision regarding the use of technology in terms of creativity and automation, and the consequent publication of research in scientific journals in an easy and motivating way.

Academic Writing

Writing allows knowledge to be generated through research, socializing ideas and thoughts to produce science. The writing process consists of a set of steps including pre-writing, writing, reviewing, editing and publishing to write an essay, a short story, a poem, a letter, etc. Writing is a complex and recursive process where different views converge on a com-

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 307-327.

mon idea. In this order of ideas, Marinkovich (2002) states that writing is conceived as "non-prescriptive, focused on the process, which in the light of the contributions derived from psychological, social and linguistic theories, allows us to approach what really happens when we learn to write" (p. 226). Therefore, to structure academic texts it is necessary to consider several aspects, such as: identifying the subject, proposing variables, determining chapters, citing bibliographic references, paraphrasing, writing, and concluding, all this will allow forming research scenarios with scientific approaches without problem.

On the other hand, Neira and Ferreira (2011) point out that in the "writing process, the author must carry out different activities of higher thought in which several factors interact in the development of the text" (p. 47). Therefore, writers must consider ideas and concepts to organize thinking correctly. Likewise, Porter (2002) points out that "interconnected writing between networks strengthens the process by taking advantage of the Internet and virtual tools, whose interconnection will revolutionize new practices of production, interaction and publication of written texts" (p. 39). Today there are new pedagogical forms such as virtual education, where writers connect *online* with other authors with the purpose of exchanging ideas, i.e., working collaboratively and obtaining rapid, automated results, framed in the production of scientific texts and improving scientific relations.

Calle (2014), meanwhile, states that writers at the time of writing:

> They can combine different ways in their process of constructing meanings using images, sounds, graphics, in a complementary way, achieving that they act as a unit with complete sense and if one of them is deleted from the text, its meaning changes or disappears (p. 43).

In this sense, writers should enable the exchange of ideas, graphics, previous publications, etc. to feed back research and enable indexing in scientific journals.

Finally, academic writing is also called academic literacy, understood as the ability that teachers and students must have to produce scientific and academic texts. Carrasco (2016) considers that to train in the environments of academic and scientific writing "we must rethink the approach we have regarding writing in general, reconsider the process of writing and overcome some fears we may have for writing" (p. 158). Finally, make a good statement of what really is wanted to communicate and how would be the most effective and clear way to transmit knowledge,

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 307-327.

without forgetting that the dissemination of academic writing contributes to the trajectory of scientific communities in the production of science.

Academic writing in higher education

Academic writing allows researchers the opportunity to discover ideas and concepts for the generation of new knowledge, therefore, the development of skills for writing texts is a challenge in the production of science. In this reality, Ganga Contreras *et al*. (2015) state that:

> One of the primary tasks that the university must assume is the one related to the generation of new knowledge, which must be at the service of the society, because these entities must assume the responsibility of generating and radiating the intellectual life of their academic community (p. 2).

Hence, for Cassany (2006) "writing is a process of elaborating ideas, in addition to a linguistic task of writing. It is much more than a means of communication, it is a learning instrument" (p. 18). Consequently, writing involves reviewing and reorganizing ideas to generate new knowledge, through the continuous adjustment of the written communicative situation, and being a significant contribution in the construction and production of research in a scientific way.

It should be noted that the reading materials and the usual writings in the university belong to the so-called academic genres. According to Cassany (2006), the interest in studying each gender lies in the fact that by knowing how it is and how it works, its teaching and learning can be improved, since "learning to use a gender is learning to develop the professional practices that develop in it" (p. 23). In other words, to write new academic texts, one must consider research and publications by faculty and students of the academy, and continue with new research for the benefit of the university scientific community.

For his part, Castelló (2009) argues that the writing skills acquired by university students should be:

> To conceive and use writing as a tool for learning and thinking.
> To know and regulate the activities involved in the process of composition of academic texts.
> To be part of the scientific community and discuss other academic texts.
> To write from and for a reference discursive community (p. 28).

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 307-327.

Consequently, higher education takes on a challenge in university students to enable them to write tasks in all areas of knowledge such as: research, publications, presentations, reports, essays, questionnaires, etc., with the purpose of producing science. Hence, it will allow developing capacities and skills to generate new knowledge in all research scenarios.

Academic writing with virtual tools

Currently, "the construction of scientific knowledge originated by research activities is one of the main tasks of the professors-researchers" (Márquez & Gómez, 2018, p. 32). Thus, it is necessary that in current times academic writing becomes the main product of the university, which will allow to contribute significantly to the production of science to align with the modern and technological world. However, to strengthen academic writing, technologies exist today. Fidalgo (2021) states "the role of technology is crucial within the field of academic writing, as students turn to online tools to write their academic works, especially when writing their texts" (p. 2). Thus, in the practice of academic writing, several types of tools have appeared that help in the digital production of written texts, among which stand out office packages such as: "WPS Office, Libre Office, Open Office, Google Docs, Draft, Shaxpir 4, Think Free Online Editor. Also in programs like Microsoft Word, Apple Pages, WordPerfect" (Fuentes Huerta, 2019, p. 1).

There are also online word processors, such as the cloud services offered by Microsoft and Google, which "are collaboration platforms […] based on the cloud, they allow access to a set of computer programs (word processing, instant messaging, professional email, file sharing, etc.) from a computer" (Mozzaik, 2023, p. 2). Hence, they allow academic writing to be done collaboratively, these tools have advanced features such as allowing the construction of knowledge together, recording the modifications that are being made to the text, accounting for the time invested, registering online comments, sending notifications to email, among others.

In addition to digital tools for word processing, there are others that complement each other to improve academic writing. As pointed out by Valverde (2018), some examples of university initiatives in the management of multifunctional digital platforms are indicated:

> The RedacText 2.0 interactive platform, created by the Complutense University of Madrid, specializes in the study of teaching and learning processes in academic texts. Also, LEA (Laboratorio de Enseñanza

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 307-327.

> Aprendizaje), is a platform of the University of Chile that has different virtual courses on academic writing for students to improve their writing with autonomy. Another example is the Javerian Writing Center of the Pontifical Javerian University of Cali in Colombia, which allows access to resources for teachers and students of academic writing and has free tutoring services (p. 45).

There are several universities that have implemented high-reach virtual platforms to promote writing in students. The latter are known as social tools and serve to process texts, as they promote the development of autonomous and collaborative skills, turning academic writing into healthy recreational scenarios for the production of scientific texts.

Writing and digital technology

The concept of "digital writing" is related to the use of information and communication technologies. The evolution of these implies giving it the level of importance that currently predominates in technological resources. Porter (2002) speaks of "interconnected or internetworked writing to integrate the writing process into Internet-based communication, and the interconnection that revolutionizes new production, interaction, and publishing practices" (p. 43). So, ICTs allow access to information instantaneously, of which it will be the writers who take advantage of publications, PDF articles, virtual books, to serve as an input in academic writing, without forgetting to cite the sources or bibliographic references, so that the written document has the respective relevance and seriousness.

New technologies have created a more interactive world of communication and as Slotnisky (2015) points out:

> Much of this communication between people is done through a digital medium such as Twitter, Facebook, Messenger, e-mail or chat platforms. Independent of the rules imposed by these platforms, there are two characteristics that are common when communicating, and they are the abbreviations and the immediacy in the act of writing and reading that allows the typed text to be shared instantly (p. 15).

According to this author, perhaps it is the fast-paced moment that society is currently experiencing that leads to faster communication and the demand for an immediate response. For this reason, abbreviations and symbols are used to indicate something that wants to be expressed. Thus, ICTs are an alternative for faster and more effective communica-

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 307-327.

tion, at the same time to awaken the interest of writing in young people and adults.

Therefore, digital spaces have managed to attract people's attention to the point that social networks, search sites and web pages are the first scenarios that captivate the attention of thousands of people every day, and lead them not only to read large amounts of information, but also to write about them (Escofet, 2020).

For its part, Frescura (2016) proposes to analyze the tensions between the renewal and the permanence of educational practices, within the framework of a pedagogical experience of teaching writing with ICT through an academic writing workshop in a teacher training institute. The case study consisted of the production of a reading report by the students. The situation was raised as a writing proposal. A fundamental aspect was the use of ICT, and concluding that although the hybridization of practices and knowledge presents a series of obstacles, it also enables a series of learning.

Virtual tools for writing

Currently there are a lot of digital tools that help us with writing, whether for a beginner or an expert. According to Singh and Mayer (2014), these tools make "writing a creative, effective and manageable activity and not a cumbersome and boring process. They also help to speed up writing, improve the quality of the text and are adaptable to the habits, attitudes and interests of the writer" (p. 24). The most important are summarized below:

Table 1
Applications and digital platforms for academic writing

Top applications and digital platforms	Description
Scrivener	Text processing and layout software for writers. Operating System: Windows, macOS, iOS.
iA Writer	Program for text editing; it allows organization. Operating System: Windows, macOS, iOS.
Ulysses	Digital application for writing; it has a text management system and several functions. Operating System: macOS, iOS.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 307-327.

Top applications and digital platforms	Description
Literauts	Online program for writing; it has several applications for writing. Operating System: iOS and Android.
yWriter	Text processor that allows organizing the ideas. Operating System: Windows.
Evernote	Program to create and organize notes. Operating System: Windows, macOS, iOS, Android.
OneNote	Program for taking notes, digital notebook to organize thoughts. With Microsoft OneNote, you take notes from your mobile phone and sync to other devices.
Writers Cafe	Tool that allows organizer all the elements that are part of a script. Operating System: Windows.
Plume creator	Program for writers with a powerful word processor and has several functions. Operating System: Windows, Linux.
Final Draft	Writing program for writing and formatting scripts. Operating System: Windows, macOS.
Storyist	Creative writing application with a powerful word processor and several features. Operating System: macOS.
Manuskript	Open source digital tool for writers, character management, plot development, distraction-free editor, etc. Operating System: Windows, macOS, Linux
Mendeley, JabRef, CiteULike EndNote Papers, Zotero	Web tools to manage bibliography of academic writing. Operating System: Windows, MacOS, Linux, Android, iOS.

Source: Own elaboration from Torres *et al.* (2020).

All these tools allow teachers and students a series of technological benefits to choose the platform or application according to what they want to write. In this regard, writing academic texts is one of the most frequent activities carried out in the university; therefore, the need to continue promoting these writings in order to respond to the needs of the production of science in an autonomous and collaborative creative way. Finally, it is important for teachers to use these tools and virtual environments according to their students' learning needs.

Additionally, a systematic review was carried out on the main research related to technological pedagogical strategies, consulting a series

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 307-327.

of research articles with respect to the subject. After analyzing pedagogical strategies such as collaborative work, autonomous learning and competency-based learning, it was observed that the most used tools by teachers were virtual environments such as blogs, word processors and virtual platforms.

For the purposes of this research, the digital tools Scrivener and Evernote were specifically studied and analyzed (Jara, 2021).

Scrivener Tool

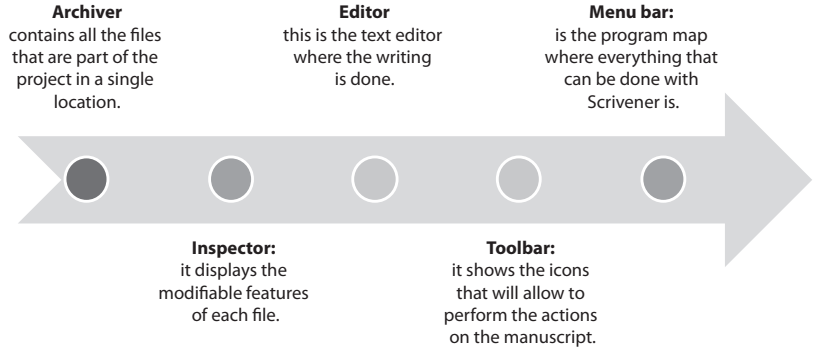
In the words of McLean (2017) *Scrivener* is a writing tool that is characterized by including:

> Project management and organization modules, but it is best known for its contributions in organizing complicated projects. It is a word processor and project management tool that remains with the writer from the first idea to the final draft (p. 1).

Scrivener is a program used for text processing and for layout, which allows to organize documents more efficiently, annotations to have the writings better organized. Scrivener is much more than most writing programs or a traditional word processor, since traditional word processors conceive of text as a large extension of words, while Scrivener poses it as a set of scenes that are related to each other, but at the same time independent, i.e., this program focuses on the parts that make up the entire text (Wheat, 2013).

Scrivener consists of five basic parts:

Figure 1
Scrivener Basic Parts

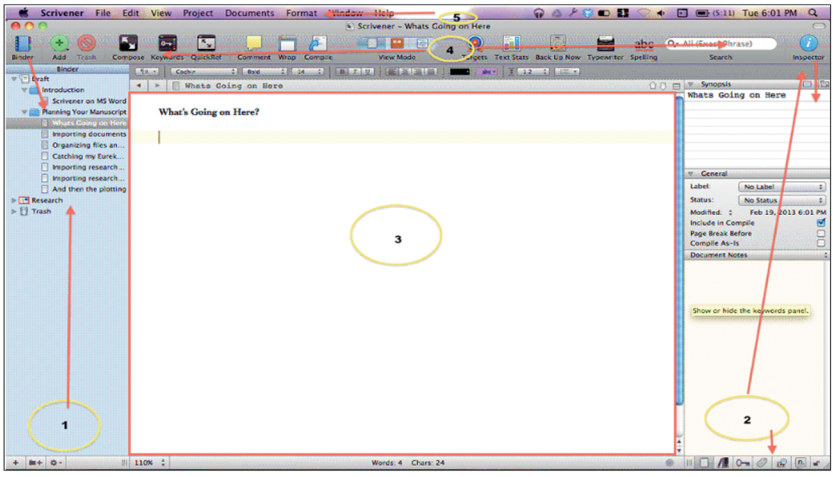


Source: taken from Trigo (2013, p. 4).

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 307-327.

However, it should be noted that the five basic parts are located within the interface, a situation that allows to organize the writings without difficulty.

Figure 2
Scrivener interface

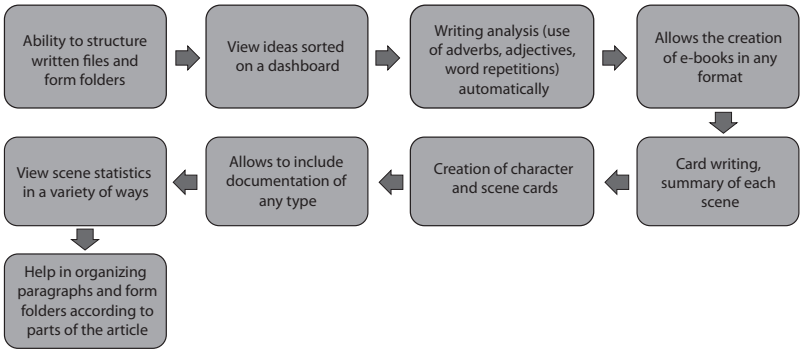


Source: Taken from Trigo (2013).

Features of Scrivener

The features incorporated in the Scrivener program allow writers to achieve real productivity in the writing of texts of all kinds. According to Olier (2019), Scrivener's most outstanding features are the following:

Figure 3
Scrivener Features



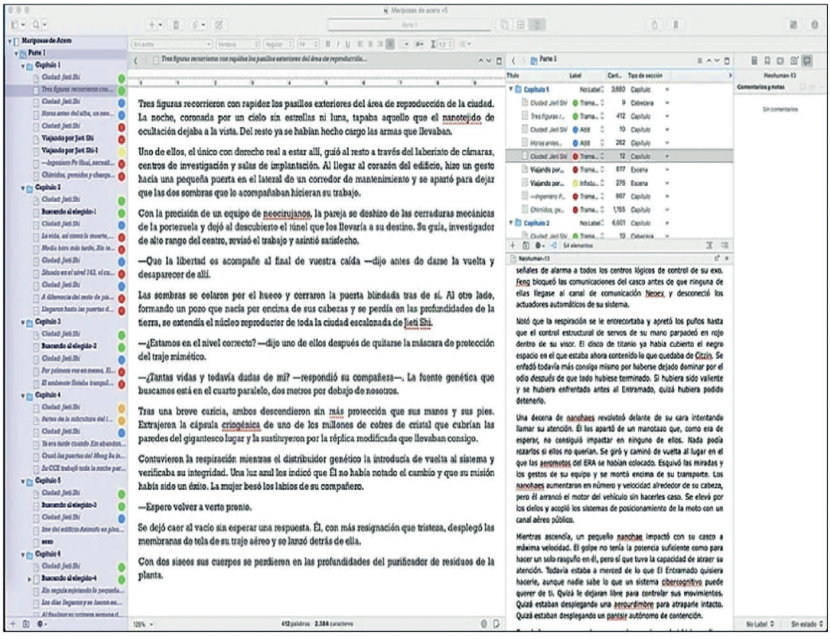
Source: taken from Olier (2019).

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 307-327.

Scrivener is a writing software designed for writers. It is easily downloaded from the internet, it can be opted for free or paid, without forgetting that this virtual tool contributes significantly mainly in organizing information in a simple way, scenario that will allow academic and all kinds of writings to be made easily, scientifically and creatively. The screen is then displayed:

Figure 4
Scrivener display



Source: taken from Olier (2019).

Finally:

> Scrivener provides a friendly environment for the collection and organization of research material. With the possibility of importing and viewing documents, images and notes […] it is a digital repository that stores all the elements necessary for a coherent academic document (Scrivener, 2023).

Finally, it has advanced functions for effective writing, as it adapts easily to the processes of scientific writing.

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 307-327.

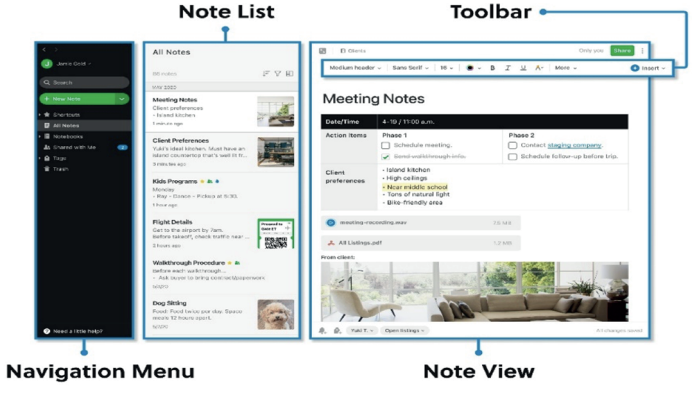
Evernote Tool

Evernote "is a tool that serves to make annotations and reminders of all kinds, sharing your notes on your computer, phone and tablet in a synchronized way. It is possible to include screenshots, files and images to complete the information" (Gaitán, 2024, p. 2). In this sense, it is a tool with several academic benefits that strengthen academic writing, helps to make annotations in the form of text, include images, place documents in the text easily to organize the information to structure academic essays efficiently.

Evernote can be used by paying for a license or by a paid web service. This app is available for Android, iOS and natively on Microsoft Windows and Mac. Additionally, there is a web version that can be used from any browser and works through a subscription service that allows synchronization with local applications. According to Evernote (2021), the interface consists of the following basic elements:

- *Navigation menu*: it contains items search, notebooks, new notes, shortcuts.
- *Notes list*: is the central panel of the application and contains elements such as sorting and filters options.
- *Notes view*: Also known as the Notes panel, which contains elements for note magnification, note moving, sharing, and other note editing actions.
- *Toolbar*: it allows to edit notes and contains elements to configure the type of text, style, color, format and font size.

Figure 5
Evernote Interface



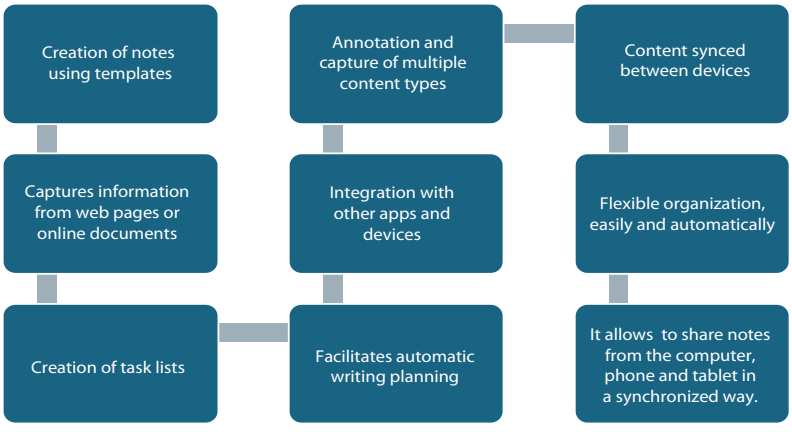
Source: taken from Evernote (2021).

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 307-327.

Evernote Features

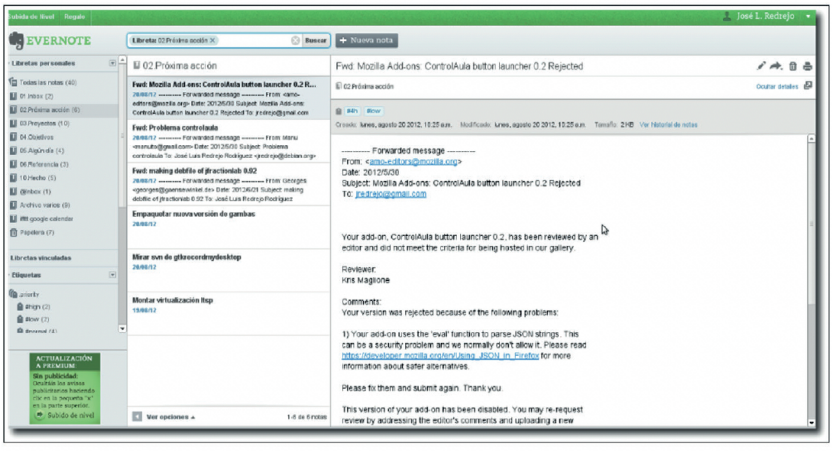
Among the main features of the Evernote tool, the following are described:

Figure 6
Evernote Features



Source: Taken from Castro (2022).

Figure 7
Evernote Display



Source: taken from Evernote (2021).

Sophia 38: 2025.

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Evernote is therefore a tool that greatly assists in the process of research of all kinds, since it allows to collect information and keep everything organized, for which people can use several of the functions offered by the tool, such as: grouping the research into several notebooks, screenshots of online journal articles, screenshots of images, scanning of documents, annotations in images and PDF files, recording of interviews and conversations, sharing notes and notebooks with the participants of the research group.

Also, Evernote is an excellent tool that allows to improve the task of the teacher inside and outside the classroom, so Rodríguez (2019) points out five reasons for a teacher to start using Evernote:

- *Sort the ideas*: the teacher's ideas can be saved and classified by means of labels.
- *Building digital archive*: people can store internet pages, images, magazine articles, and all kinds of files.
- *Class planning and registration*: Template formats can be created in Evernote to plan classes and record the activities that are carried out.
- *Sharing with students and teachers*: the available material can be shared and permissions can be given for reading or editing.
- *Access from anywhere*: information can be accessed through the web, from any type of device.

Evernote is an application that facilitates students to investigate autonomously and collect new complementary information, according to the questions, motivations or interest generated by the specific topics of a course.

Evernote Benefits

The benefits offered by this application are diverse, since students can organize notes, take photographs of brochures on paper; capture photos of activities in the classroom or drawings on blackboards, organize schedules, task lists, contacts, among others. In the meantime, the teacher will likely use Evernote to organize course design and establish communication with their students, as well as record a discussion or lecture and make it available in a shared notebook, and provide oral or written feedback to students (Korzaan & Lawrence, 2016). This application can replace the previous common method of classical reading and note-taking on paper.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 307-327.

Based on the study by Korzaan and Lawrence (2016), when students begin to learn and take advantage of technology, they can know the power of it in the transformation of organizations. In addition, they motivate students to employ powerful technology in real life with the prospect that they can see better possibilities for themselves or for the organizations they can lead later.

Evernote's role as a graphical organizer also offers many facilities. The schema or graphical organizer will look more orderly with the help of the table template. This may be because some students sometimes cannot write clearly, which can confuse them or their readers.

For their part, DiCecco and Gleason (2002) state that the use of a computerized graphic organizer for persuasive writing by Hispanic students with specific learning disabilities shows that the group of students who receive a graphic organizer may show more rational thinking than students who do not use it.

In turn, Vendityaningtyas *et al.* (2020) mention that graphic organizers can improve student writing. The teacher can also perform well in guiding students to use the outline when writing a counting text. These results show that it is significant to outline and organize the writing.

Conclusions

Writing is an academic challenge for teachers and students, i.e., translating ideas into written texts according to the knowledge learned. But this reality has not been reflected in a good percentage, given that writing becomes complex due to the lack of knowledge of virtual platforms, which facilitate the writing process quickly, automatically and creatively. Therefore, the Scrivener tool was created, which is a virtual software to make the life of the writer easier, people just have to download it easily from the Internet, it has more flexible options to organize and write a text, whether it is a script, a scientific book, a novel or a research article.

Scrivener offers a different way to approach a work with respect to other writing programs; while others conceive the text as a large extension of words, Scrivener poses as a set of related scenes, but at the same time independent, and it motivates writers to create their own ideas from any field.

Among the challenges for Evernote can be highlighted, requiring a constant connection to the internet. It must also be provided by suitable hardware. It is designed to be used on computer, laptop or smartphone.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 307-327.

It is suggested that the institution could provide sufficient means to meet this need, such as constant internet connection. This is because, despite its challenges, this app is beneficial for students and teachers to become more tech-literate in the learning process to face the digital age.

Finally, the indicated virtual applications are important for academic writing, as they generate a significant contribution to their development, taking advantage of technologies. This is what Aguilar Gordón (2011) says: "Identifying the appropriate technology and making proper use of it is a fundamental task of every human being today" (p. 132), so we must take advantage of virtual scenarios, in this case it is the use of technological applications for writing and achieve the impulse for the publication of academic articles in an agile, automated and creative way, which associated with information and communication technologies contribute to the generation of scientific communities.

In other words, Scrivener and Evernote are digital tools for academic writing that allow to insert written notes, voice notes, abstracts, documents, images, quotes from authors, audios, links, etc. Also, they generate a significant contribution to the development of academic writing, managing to contribute to the impulse of the publication of academic and scientific articles with creativity and achieve a greater optimization of intellectual resources, time and effort when writing. All this will allow to score learning achievements from the academy.

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Declaration of Authorship - Taxonomy CRediT	
Authors	**Contributions**
Verónica Patricia Simbaña Gallardo	Conceptualization. Review of primary sources and data processing. Drafting of the first draft
Lilian Mercedes Jaramillo Naranjo	Research. Data analysis, organization and integration of data collected.
Santiago Fernando Vinueza Vinueza	Data analysis. Organization and integration of collected data, conclusions and final drafting.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 307-327.

Artificial Intelligence Use Statement
Verónica Patricia Simbaña Gallardo, Lilian Mercedes Jaramillo Naranjo and Santiago Fernando Vinueza Vinueza, DECLARE that the elaboration of the article ***The challenge of academic writing using virtual tools,*** did not have the support of Artificial Intelligence (AI).

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Editorial guidelines / *Normas editoriales*

Publication guidelines in «Sophia»

ISSN: 1390-3861 / e-ISSN: 1390-8626

1. General Information

«Sophia» is a scientific publication of the *Salesian Polytechnic University of Ecuador,* published since January 2006 in an uninterrupted manner, with a fixed biannual periodicity, specialized in Philosophy of Education and its interdisciplinary lines such as Epistemology, Deontology, Aesthetics, Critical Studies, Hermeneutics, Axiology, Ontology, Philosophical Anthropology, Sociology, Philosophical Analytics, among others, all linked to the field of Education.

It is scientific journal, which uses the peer-review system, under double-blind review methodology, according to the publication standards of the American Psychological Association (APA). Compliance with this system allows authors to guarantee an objective, impartial and transparent review process, which facilitates the publication of their inclusion in reference databases, repositories and international indexing.

«Sophia» is indexed in **(SCOPUS)** Emerging Sources Citation Index **(ESCI)** from Web of Science; in Scientific Electronic Library Online **(SciELO)**; in the Scientific Information System **(REDALYC)**; in the directory and selective catalog of the Regional Online Information System for Scientific Journals of Latin America, the Caribbean, Spain and Portugal **(LATINDEX)**, in the Matrix of Information for the Analysis of Journals **(MIAR)**, in Integrated Classification of Scientific Journals **(C.I.R.C)**, in the Academic Resource Index **(Research Bible)**, in the Ibero-American Network of Innovation and Scientific Knowledge **(REDIB)**, in the Portal for the dissemination of scientific production **(Dialnet)**; in Latin American Bibliography in Journals of Scientific and Social Research **(BIBLAT)**; in the Directory of Open Access Journals **DOAJ** and in repositories, libraries and specialized catalogs of Latin America.

The journal is published in a double version: printed (ISSN: 1390-3861) and digital (e-ISSN: 1390-8626), Spanish and English, each work being identified with a DOI (Digital Object Identifier System).

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2. Scope and policy

2.1. Theme

Original contributions in Philosophy of Education, as well as related areas: Epistemology, Deontology, Aesthetics, Critical Studies, Hermeneutics, Axiology, Ontology, Philosophical Anthropology, Sociology, Philosophical Analytics,... and all interdisciplinary related disciplines with a philosophical reflection on education

2.2. Contributions

«Sophia» publishes critical studies, reports and proposals, as well as selected state-of-the-art literature reviews related to Philosophy of education. Accepting also results of empirical research on Education, written in Spanish and/or English.

The contributions can be:

- **Reviews**: 10,000 to 11,000 words of text, without including charts and references. Justified references would be specially valued. (around a minimum of 60 works)
- **Research**: 8,000 to 9,500 words of text, without including title, abstracts, descriptors, charts and references.
- **Reports, studies and proposals:** 8,000 to 9,500 words of text, without including title, abstracts, charts and references.

2.3. Characteristics of the content

All works presented for publication in «Sophia» must comply with the characteristics of scientific research:

- Be original, unpublished and relevant
- Address issues that respond to current problems and needs
- Contribute to the development of scientific knowledge in the field of Philosophy of Education and its related areas
- Use adequate, clear, precise and comprehensible language
- Not have been published in any medium or in the process of arbitration or publication.
- Not to be the result of thesis work, monographs, and/or degree projects
- Do not exceed 2% similarity with other documents.

Depending on the relevance of the article, it will be considered as special contributions and will occasionally be published:

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- Works that exceed the stated extent
- Works that do not correspond to the subject of the reflection foreseen for the respective issue

2.4. Periodicity

«Sophia» has a biannual periodicity (20 articles per year), published in January and July and counts by number with two sections of five articles each, the first referring to a **Monographic** topic prepared in advance and with thematic editors and the second, a section of **Miscellaneous**, composed of varied contributions within the theme of the publication.

3. Presentation, Structure and Submission of the Manuscripts

Texts will be presented in Arial 12 font, single line spacing, complete justification and no tabs or blank spaces between paragraphs. Only large blocks (title, authors, summaries, keywords, credits and headings) will be separated with a blank space. The page should be 2 centimeters in all its margins.

Papers must be submitted in a Microsoft Word document (.doc or .docx), requiring that the file be anonymized in File Properties, so that the author/s identification does not appear.

Manuscripts must be submitted only and exclusively through the OJS (Open Journal System), in which all authors must previously register. Originals sent via email or other interfaces are not accepted.

3.1. Structure of the manuscript

For those works that are empirical investigations, the manuscripts will follow the IMRDC structure, being optional the Notes and Supports. Those papers that, on the contrary, deal with reports, studies, proposals and reviews may be more flexible in their epigraphs, particularly in material and methods, analysis, results, discussion and conclusions. In all typologies of works, references are mandatory.

A. Empirical research

Its purpose is to contribute to the progress of knowledge through original information, following the IMRDC structure: Introduction (objectives, previous literature). Materials and methods, Analysis and Results, Discussion, integration and conclusions. Following the criteria set by UNESCO, it is these types of scientific texts are also called as: "original memories"

The recommended structure, especially in works that include empirical research, is the following:

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1) Title (Spanish) /Title (English): Concise but informative, in Spanish on the first line and in English on the second. A maximum of 85 characters with spaces are accepted. The title is not only the responsibility of the authors, changes being able to be proposed by the Editorial Board.

2) Identification data: Of each of the authors, organized by priority. A maximum of 3 authors will be accepted per original, although there may be exceptions justified by the topic, its complexity and extent. Next to the names must follow the professional category, work center, email of each author and complete ORCID number. Aspects that must be included in the Cover Letter, must also be uploaded to the OJS system of the journal, in the Metadata section and /or in a word document attached to the file containing the work proposed for the evaluation.

3) Abstract (Spanish) / Abstract (English): It will have a minimum length of 210 and a maximum of 220 words in Spanish; and 200 and maximum 210 words in English. The abstract will describe concisely and in this order: 1) Justification of the topic; 2) Objectives; 3) Methodology; 4) Main results; 5) Main conclusions. It must be impersonally written "This paper analyzes...". In the case of the abstract, the use of automatic translators will not be accepted due to their poor quality.

4) Keywords (Spanish) / Keywords (English): A maximum of 6 keywords must be presented for each language version directly related to the subject of the work. The use of the key words set out in UNESCO's Thesaurus and of the journal itself, located in the following link: https://sophia.ups.edu.ec/tesauro_sophia.php, will be positively valued.

5) Introduction and state of the issue: It should include the problem statement, context of the problem, justification, rationale and purpose of the study, using bibliographical citations, as well as the most significant and current literature on the topic at national and international level..

6) Material and methods: It must be written so that the reader can easily understand the development of the research. If applicable, it will describe the methodology, the sample and the form of sampling, as well as the type of statistical analysis used. If it is an original methodology, it is necessary to explain the reasons that led to its use and to describe its possible limitations.

7) Analysis and results: It will try to highlight the most important observations, describing them, without making value judgments, the material and methods used. They will appear in a logical sequence in the text and the essential charts and figures avoiding the duplication of data.

8) Discussion and conclusions: Summarize the most important findings, relating the observations themselves with relevant studies, indicating contributions and limitations, without adding data already mentioned in other sections. Also, the discussion and conclusions section should include the deductions and lines for future research.

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9) Supports and acknowledgments (optional): The Council Science Editors recommends the author (s) to specify the source of funding for the research. Priority will be given to projects supported by national and international competitive projects. In any case, for the scientific evaluation of the manuscript, it should be only anonymized with XXXX for its initial evaluation, in order not to identify authors and research teams, which should be explained in the Cover Letter and later in the final manuscript.

10) The notes (optional) will go, only if necessary, at the end of the article (before the references). They must be manually annotated, since the system of footnotes or the end of Word is not recognized by the layout systems. The numbers of notes are placed in superscript, both in the text and in the final note. The numbers of notes are placed in superscript, both in the text and in the final note. No notes are allowed that collect simple bibliographic citations (without comments), as these should go in the references.

11) References: Bibliographical citations should be reviewed in the form of references to the text. Under no circumstances should references not mentioned in the text be included. Their number should be sufficient to contextualize the theoretical framework with current and important criteria. They will be presented alphabetically by the first last name of the author.

b. Reviews

Literature reviews are based on the analysis of major publications on a giveLiterature reviews are based on the analysis of major publications on a given topic; Its objective is to define the current state of the problem and to evaluate the investigations carried out. Its structure responds to the phases of the theme/ problem, contributions of researchers or teams, changes in theory or main theoretical currents; unsolved problems; current and future trends (Giordanino, 2011). According to UNESCO, this type of work is also known as "recapitulative studies"

1) Title (Spanish) /Title (English): Concise but informative, in Spanish on the first line and in English on the second. A maximum of 85 characters with spaces are accepted. The title is not only the responsibility of the authors, changes being able to be proposed by the Editorial Board.

2) Identification data: Of each of the authors, organized by priority. A maximum of 3 authors will be accepted per original, although there may be exceptions justified by the topic, its complexity and extent. Next to the names must follow the professional category, work center, email of each author and complete ORCID number. Aspects that must be included in the Cover Letter, must also be uploaded to the OJS system of the journal, in the Metadata section and /or in a word document attached to the file containing the work proposed for the evaluation.

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4) Keywords (Spanish) / Keywords (English): A maximum of 6 keywords must be presented for each language version directly related to the subject of the work. The use of the key words set out in UNESCO's Thesaurus and of the Journal itself will be positively valued.

5) Introduction: It should include a brief presentation of the topic, the formulation of the purpose or objective of the study, the context of the problem and the formulation of the problem that is proposed, the presentation of the idea to be defended, the justification explaining the importance, the relevance of the study; the methodological framework used, and finally, a brief description of the structure of the document. In the justification it is necessary to use bibliographical citations as well as the most significant and current literature on the subject at national and international level.

6) Body or development of the document: It implies putting into practice throughout the text, a critical attitude that should tend towards the interpellation, in order to attract the attention of the topic and the problem treated. The writer must generate in the reader the capacity to identify the dialogical intention of the proposal and to promote an open discussion.

7) Conclusions: Objectively state the results and findings. Offer a vision of the implications of the work, the limitations, the tentative response to the problem, the relations with the objective of the research and the possible lines of continuity (to fulfill this objective it is suggested not to include all the results obtained in the research). The conclusions should be duly justified according to the research carried out. The conclusions may be associated with the recommendations, evaluations, applications, suggestions, new relations and accepted or rejected hypotheses.

8) Bibliography: It is the set of works used in the structuring of the scientific text. It should include only the reference of the works used in the research. Bibliographical references should be ordered alphabetically and conform to the international APA standards, in their sixth edition.

3.2. Guidelines for references

Periodic Publications

Journal article (author): Valdés-Pérez, D. (2016). Valdés-Pérez, D. (2016). Incidencia de las técnicas de gestión en la mejora de decisiones administrativas

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[Impact of Management Techniques on the Improvement of Administrative Decisions]. Retos, 12(6), 199-2013. https://doi.org/10.17163/ret.n12.2016.05

Journal Article (Up to six authors): Ospina, M.C., Alvarado, S.V., Fefferman, M., & Llanos, D. (2016). Introducción del dossier temático "Infancias y juventudes: violencias, conflictos, memorias y procesos de construcción de paz" [Introduction of the thematic dossier "Infancy and Youth: Violence, Conflicts, Memories and Peace Construction Processes"]. Universitas, 25(14), 91-95. https://doi.org/10.17163/uni.n25.%25x

Journal article (more tan six authors): Smith, S.W., Smith, S.L. Pieper, K.M., Yoo, J.H., Ferrys, A.L., Downs, E.,... Bowden, B. (2006). Altruism on American Television: Examining the Amount of, and Context Surronding. Acts of Helping and Sharing. Journal of Communication, 56(4), 707-727. https://doi.org/10.1111/j.1460-2466.2006.00316.x

Journal article (without DOI): Rodríguez, A. (2007). Desde la promoción de salud mental hacia la promoción de salud: La concepción de lo comunitario en la implementación de proyectos sociales. Alteridad, 2(1), 28-40. (https://goo.gl/zDb3Me) (2017-01-29).

Books and Book Chapters

Full books: Cuéllar, J.C., & Moncada-Paredes, M.C. (2014). El peso de la deuda externa ecuatoriana. Quito: Abya-Yala.

Chaprter of book: Zambrano-Quiñones, D. (2015). El ecoturismo comunitario en Manglaralto y Colonche. En V.H. Torres (Ed.), Alternativas de Vida: Trece experiencias de desarrollo endógeno en Ecuador (pp. 175-198). Quito: Abya-Yala.

Digital media

Pérez-Rodríguez, M.A., Ramírez, A., & García-Ruíz, R. (2015). La competencia mediática en educación infantil. Análisis del nivel de desarrollo en España. Universitas Psychologica, 14(2), 619-630. https://doi.org.10.11144/Javeriana.upsy14-2.cmei

It is prescriptive that all quotations that have DOI (Digital Object Identifier System) are reflected in the References (can be obtained at http://goo.gl/gfruh1). All journals and books that do not have DOI should appear with their respective link (in their online version, if they have it, shortened by Bitly: https://bitly.com/) and date of consultation in the indicated format.

Journal articles should be presented in English, except for those in Spanish and English, in which case it will be displayed in both languages using brackets. All web addresses submitted must be shortened in the manuscript, except for the DOI that must be in the indicated format (https://doi.org/XXX).

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 331-340.

3.3. Epigraphs, Figures and Charts

The epigraphs of the body of the article will be numbered in Arabic. They should go without a full box of capital letters, neither underlined nor bold. The numbering must be a maximum of three levels: 1. / 1.1. / 1.1.1. A carriage return will be established at the end of each numbered epigraph.

The charts must be included in the text in Word format according to order of appearance, numbered in Arabic and subtitled with the description of the content.

The graphics or figures will be adjusted to the minimum number required and will be presented incorporated in the text, according to their order of appearance, numbered in Arabic and subtitled with the abbreviated description. Their quality should not be less than 300 dpi, and it may be necessary to have the graph in TIFF, PNG or JPEG format.

4. Submission Process

The receipt of articles is permanent, however, considering that the publication of the Sophia Journal is bi-annual, the manuscripts must be sent at least one period before the date stipulated in the corresponding Call.

The manuscripts must be sent through the OJS (Open Journal System) system of the journal, for which it is necessary that the author previously registers in the respective space (enter in the following link: http://sophia.ups.edu.ec/index.php/sophia/user/register, complete the form and follow each of the suggested steps).

The five documents that must be submitted are:

1. **Letter of introduction.** This document includes a declaration stating that the submitted manuscript is an original contribution, has not been submitted to or is under review by any other journal. It also includes the acceptance of the signing authors, allowing, if applicable, the editorial team of Sophia to make changes to the content, formal aspects, and style of the document following the journal's requirements after the manuscript review process. Additionally, the Letter of introduction or Presentation contains a Rights Transfer section (partial transfer of rights to the publisher) and a Conflict of Interest Declaration, in accordance with editorial guidelines. This document must be signed and submitted through the OJS system in the "Supplementary Files" section.
2. **Cover Letter.** This letter should include the following information
   Title. In Spanish in the first line, in letter Arial 14, with bold and centered, with a maximum of 85 characters with space. In English in the second line, in letter Arial 14, in italics and bold.

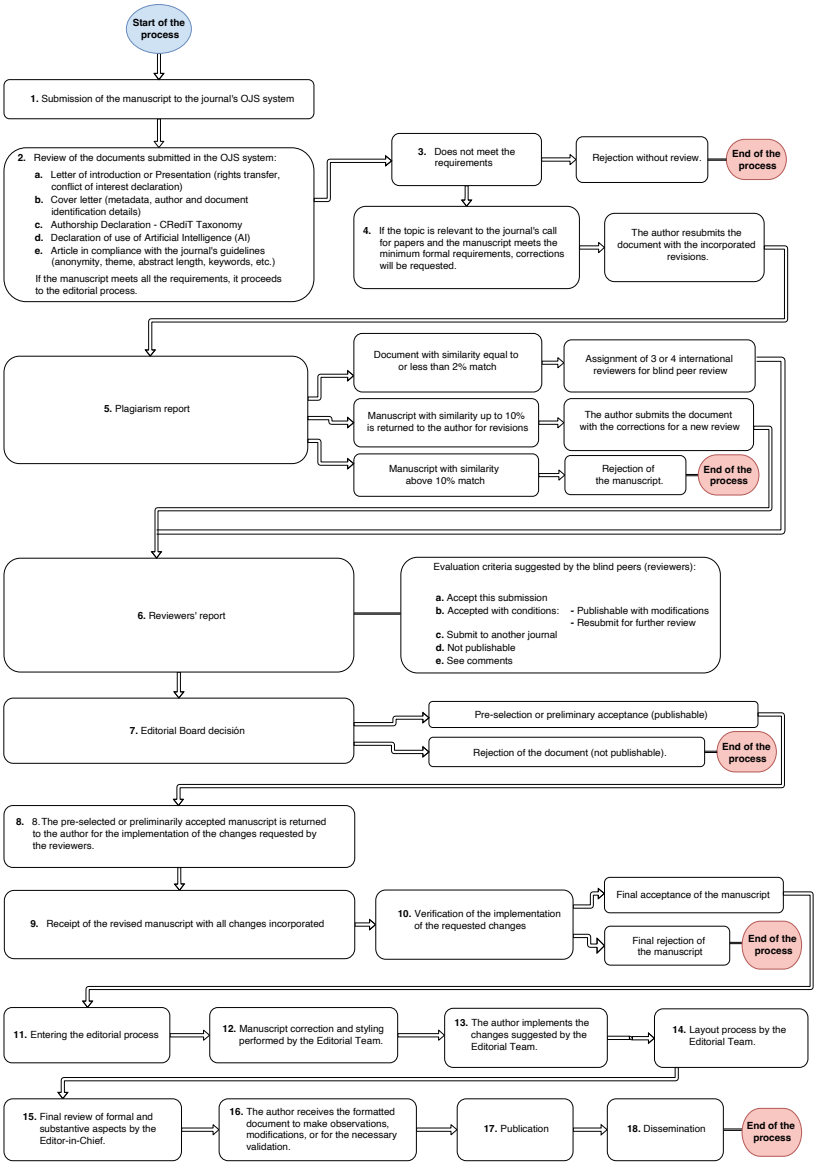
Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 331-340.

Full names and surnames of the authors. Organized in order of priority, a maximum of 3 authors are accepted per original, although there may be exceptions justified by the topic, its complexity and extent. Each name must include the name of the institution in which he/she works as well as the city, country, email and ORCID number.
Abstract (Spanish) It will have a minimum length of 210 and a maximum of 220 words. It must include 1) Justification of the topic; 2) Objectives; 3) Methodology; 4) Main results; 5) Main conclusions. It must be impersonally written "The present paper analyzes..."
Abstract. Summary with all its components, translated into English and in cursive. Do not use automatic translation systems.
Keywords (Spanish): 6 standardized terms preferably of a single word and of the UNESCO and the Journal's Thesaurus separated by commas (,).
Keywords. The 6 terms above translated into English and separated by comma (,). Do not use automatic translation systems.

3. **Authorship Declaration (CRediT Taxonomy).** Applicable for articles written by multiple authors; this document details the contribution of each author to the manuscript submitted to Sophia, in accordance with the 14 aspects outlined by the CRediT Taxonomy. This document must be signed and submitted through the OJS system in the "Supplementary Files" section. It is necessary to use the format required by the journal.
4. **Artificial Intelligence (AI) Use Declaration.** This is the formal declaration made by the author(s) regarding the level of artificial intelligence (AI) used in the preparation of the manuscript, whether in parts or components of the document. It explains in detail, clearly, and precisely how this tool was utilized in the process and/or in the presentation of the research results. The document must be signed by the responsible author(s) and submitted through the OJS system of the journal.
5. **Manuscript** totally anonymized, according to the guidelines referred in precedence.
   All authors must register with their credits on the OJS platform, although only one of them will be responsible for correspondence. No author can submit or have in review two manuscripts simultaneously, estimating an absence of four consecutive numbers (2 years).

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 331-340.

5. Article evaluation process



6. Publication interval

The font size and style as stated in section 4 (Submission Process). The interval between receipt and publication of an article is 7 months (210 days).

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 331-340.

Normas de Publicación en «Sophia»

ISSN: 1390-3861 / e-ISSN: 1390-8626

1. Información general

«Sophia» es una publicación científica de la Universidad Politécnica Salesiana de Ecuador, editada desde junio de 2006 de forma ininterrumpida, con periodicidad fija semestral, especializada en Filosofía de la Educación y sus líneas interdisciplinares como Epistemología, Deontología, Estética, Estudios Críticos, Hermenéutica, Axiología, Ontología, Antropología Filosófica, Sociología, Analítica Filosófica... vinculadas al ámbito de la educación.

Es una revista científica arbitrada, que utiliza el sistema de evaluación externa por expertos (*peer-review*), bajo metodología de pares ciegos (*doble-blind review*), conforme a las normas de publicación de la American Psychological Association (APA). El cumplimiento de este sistema permite garantizar a los autores un proceso de revisión objetivo, imparcial y transparente, lo que facilita a la publicación su inclusión en bases de datos, repositorios e indexaciones internacionales de referencia.

«Sophia» se encuentra indexada en **(SCOPUS)** Emerging Sources Citation Index **(ESCI)** de Web of Science; en Scientific Electronic Library Online **(SciELO)**; en el Sistema de Información Científica **(REDALYC)**; en el directorio y catálogo selectivo del Sistema Regional de Información en Línea para Revistas Científicas de América Latina, el Caribe, España y Portugal **(LATINDEX)**, en la Matríz de Información para el Análisis de Revistas **(MIAR)**, en Clasificación Integrada de Revistas Científicas **(C.I.R.C)**, en Academic Resource Index **(Research Bible)**, en la Red Iberoamericana de Innovación y Conocimiento Científico **(REDIB)**, en el Portal de difusión de la producción científica **(Dialnet)**; en Bibliografía Latinoamericana en Revistas de Investigación Científica y Social **(BIBLAT)**; en el Directorio de Revistas de Acceso Abierto **DOAJ** y en repositorios, bibliotecas y catálogos especializados de Iberoamérica.

La revista se edita en doble versión: impresa (ISSN: 1390-3861) y electrónica (e-ISSN: 1390-8626), en español y en inglés, siendo identificado además cada trabajo con un DOI (Digital Object Identifier System).

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 341-356.

2. Alcance y política

2.1. Temática

Contribuciones originales en materia de Filosofía de la Educación, así como áreas afines: Epistemología, Deontología, Estética, Estudios Críticos, Hermenéutica, Axiología, Ontología, Antropología Filosófica, Sociología, Analítica Filosófica,... y todas aquellas disciplinas conexas interdisciplinarmente con una reflexión filosófica sobre la educación.

2.2. Aportaciones

«Sophia» edita estudios críticos, informes, propuestas, así como selectas revisiones de la literatura (*state-of-the-art*) en relación con la Filosofía de la Educación, aceptando asimismo trabajos de investigación empírica, redactados en español y en inglés.

Las aportaciones en la revista pueden ser:

- **Revisiones:** 10.000 a 11.000 palabras de texto, sin incluir tablas y referencias. Se valorará especialmente las referencias justificadas, actuales y selectivas de alrededor de un mínimo de 60 obras.
- **Investigaciones:** 8.000 a 9.500 palabras de texto, sin incluir título, resúmenes, descriptores, tablas y referencias.
- **Informes, estudios y propuestas:** 8.000 a 9.500 palabras de texto, sin incluir título, resúmenes, tablas y referencias.

2.3. Características del contenido

Todos los trabajos presentados para la publicación en «Sophia» deberán cumplir con las características propias de una investigación científica:

- Ser originales, inéditos y relevantes
- Abordar temáticas que respondan a problemáticas y necesidades actuales
- Aportar para el desarrollo del conocimiento científico en el campo de la Filosofía de la Educación y sus áreas afines
- Utilizar un lenguaje adecuado, claro, preciso y comprensible
- No haber sido publicados en ningún medio ni estar en proceso de arbitraje o publicación.
- No ser resultado de trabajos de tesis, monografías y/o trabajos de titulación.
- No exceder el 2% de similitud con otros documentos.

Dependiendo de la relevancia y pertinencia del artículo, se considerarán como contribuciones especiales y ocasionalmente se publicarán:

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 341-356.

- Trabajos que superen la extensión manifestada
- Trabajos que no se correspondan con el tema objeto de la reflexión prevista para el número respectivo

2.4 Periodicidad

«Sophia» tiene periodicidad semestral (20 artículos por año), publicada en los meses de enero y julio; y por número cuenta con dos secciones de cinco artículos cada una, la primera referida al tema central de carácter **Monográfico** debidamente preparado y, la segunda, una sección **Miscelánea**, compuesta por aportaciones variadas dentro de la temática de la publicación.

3. Presentación, estructura y envío de los manuscritos

Los trabajos se presentarán en tipo de letra Arial 12, interlineado simple, justificado completo y sin tabuladores ni espacios en blanco entre párrafos. Se separarán con un espacio en blanco los grandes bloques (título, autores, resúmenes, descriptores, créditos y epígrafes). La página debe tener 2 centímetros en todos sus márgenes.

Los trabajos deben presentarse en documento de Microsoft Word (.doc o .docx), siendo necesario que el archivo esté anonimizado en Propiedades de Archivo, de forma que no aparezca la identificación de autor/es.

Los manuscritos deben ser enviados única y exclusivamente a través del OJS (Open Journal System), en el cual todos los autores deben darse de alta previamente. No se aceptan originales enviados a través de correo electrónico u otra interfaz.

3.1. Estructura del manuscrito

Para aquellos trabajos que se traten de investigaciones de carácter empírico, los manuscritos seguirán la estructura IMRDC, siendo opcionales los epígrafes de Notas y Apoyos. Aquellos trabajos que por el contrario se traten de informes, estudios, propuestas y revisiones sistemáticas podrán ser más flexibles en sus epígrafes, especialmente en Material y métodos; Análisis y resultados; Discusión y conclusiones. En todas las tipologías de trabajos son obligatorias las Referencias.

a. Investigaciones empíricas

Su objetivo es contribuir al progreso del conocimiento mediante información original, sigue la estructura IMRDC: Introducción (objetivos, literatura previa), Materiales y métodos; Análisis y Resultados; Discusión, integración y conclusiones. Siguiendo los criterios planteados por la Unesco, este tipo de textos científicos se llaman también como: "memorias originales"

La estructura recomendada, especialmente en trabajos que incluyen investigaciones empíricas, es la siguiente:

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 341-356.

1) Título (español) / Title (inglés): Conciso pero informativo, en castellano en primera línea y en inglés en segunda. Se aceptan como máximo 85 caracteres con espacio. El título no solo es responsabilidad de los autores, pudiéndose proponer cambios por parte del Consejo Editorial.

2) Datos de Identificación: Nombres y apellidos completos de cada uno de los autores, organizados por orden de prelación. Se aceptarán como máximo 3 autores por original, aunque pudieren existir excepciones justificadas por el tema, su complejidad y extensión. Junto a los nombres deberá incluirse, el nombre de la institución en la que trabaja así como la ciudad, el país, el correo electrónico y número completo de ORCID de cada autor aspectos que deberán constar de modo obligatorio en la Carta de Presentación, además deberán ser cargados en el sistema OJS de la revista, en la sección Metadatos y/o en un documento word adjunto al archivo que contiene el trabajo que se propone para la evaluación.

3) Resumen (español) / Abstract (inglés): Tendrá como extensión mínima de 210 y máxima de 220 palabras en español; y de 200 y máximo de 210 palabras en inglés. El resumen describirá de forma concisa y en este orden: 1) Justificación del tema; 2) Objetivos; 3) Metodología y muestra; 4) Principales resultados; 5) Principales conclusiones. Ha de estar escrito de manera impersonal "El presente trabajo analiza...". En el caso del abstract no se admitirá el empleo de traductores automáticos por su pésima calidad.

4) Descriptores (español) / Keywords (inglés): Se deben exponer máximo 6 términos por cada versión idiomática relacionados directamente con el tema del trabajo. Será valorado positivamente el uso de las palabras claves expuestas en el Thesaurus de la UNESCO y en el de la propia revista localizado en el siguiente enlace: https://sophia.ups.edu.ec/tesauro_sophia.php

5) Introducción y estado de la cuestión: Debe incluir el planteamiento del problema, el contexto de la problemática, la justificación, fundamentos y propósito del estudio, utilizando citas bibliográficas, así como la literatura más significativa y actual del tema a escala nacional e internacional.

6) Material y métodos: Debe ser redactado de forma que el lector pueda comprender con facilidad el desarrollo de la investigación. En su caso, describirá la metodología, la muestra y la forma de muestreo, así como se hará referencia al tipo de análisis estadístico empleado. Si se trata de una metodología original, es necesario exponer las razones que han conducido a su empleo y describir sus posibles limitaciones.

7) Análisis y resultados: Se procurará resaltar las observaciones más importantes, describiéndose, sin hacer juicios de valor, el material y métodos empleados. Aparecerán en una secuencia lógica en el texto y las tablas y figuras imprescindibles evitando la duplicidad de datos.

8) Discusión y conclusiones: Resumirá los hallazgos más importantes, relacionando las propias observaciones con estudios de interés, señalando aportaciones y limitaciones, sin redundar datos ya comentados en otros apartados. Asimismo, el apartado de discusión y conclusiones debe incluir las deducciones y líneas para futuras investigaciones.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 341-356.

9) Apoyos y agradecimientos (opcionales): El Council Science Editors recomienda a los autor/es especificar la fuente de financiación de la investigación. Se considerarán prioritarios los trabajos con aval de proyectos competitivos nacionales e internacionales. En todo caso, para la valoración científica del manuscrito, este debe ir anonimizado con XXXX solo para su evaluación inicial, a fin de no identificar autores y equipos de investigación, que deben ser explicitados en la Carta de Presentación y posteriormente en el manuscrito final.

10) Las notas (opcionales) irán, solo en caso necesario, al final del artículo (antes de las referencias). Deben anotarse manualmente, ya que el sistema de notas al pie o al final de Word no es reconocido por los sistemas de maquetación. Los números de notas se colocan en superíndice, tanto en el texto como en la nota final. No se permiten notas que recojan citas bibliográficas simples (sin comentarios), pues éstas deben ir en las referencias.

11) Referencias: Las citas bibliográficas deben reseñarse en forma de referencias al texto. Bajo ningún caso deben incluirse referencias no citadas en el texto. Su número debe ser suficiente para contextualizar el marco teórico con criterios de actualidad e importancia. Se presentarán alfabéticamente por el primer apellido del autor.

b. Revisiones

Las revisiones de literatura se basan en el análisis de las principales publicaciones sobre un tema determinado; su objetivo es definir el estado actual del problema y evaluar las investigaciones realizadas. Su estructura responde a las fases del tema/problema, aportes de investigadores o equipos, cambios en la teoría o las corrientes teóricas principales; problemas sin resolver; tendencias actuales y futuras (Giordanino, 2011). De acuerdo con la UNESCO, este tipo de trabajos se conocen también como: "estudios recapitulativos"

1) Título (español) / Title (inglés): El título del artículo deberá ser breve, interesante, claro, preciso y atractivo para despertar el interés del lector. Conciso pero informativo, en castellano en la primera línea y en inglés en la segunda línea. Se aceptan como máximo 85 caracteres con espacio. El título no solo es responsabilidad de los autores, también los Miembros del Consejo Editorial puede proponer cambios al título del documento.

2) Datos de Identificación: Nombres y apellidos completos de cada uno de los autores, organizados por orden de prelación. Se aceptarán como máximo 3 autores por original, aunque pudieren existir excepciones justificadas por el tema, su complejidad y extensión. Junto a los nombres deberá incluirse, el nombre de la institución en la que trabaja así como la ciudad, el país, el correo electrónico y número completo de ORCID de cada autor aspectos que deberán constar de modo obligatorio en la Carta de Presentación, además deberán ser cargados en el sistema OJS de la revista, en la sección Metadatos y/o en un documento word adjunto al archivo que contiene el trabajo que se propone para la evaluación.

3) Resumen (español) / Abstract (inglés): Tendrá como extensión mínima de 210 y máxima de 220 palabras en español; y de 200 y máximo de 210

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 341-356.

palabras en inglés. El resumen describirá de forma concisa y en este orden: 1) Justificación del tema; 2) Objetivos; 3) Metodología; 4) Principales resultados; 5) Principales conclusiones. Ha de estar escrito de manera impersonal "El presente trabajo analiza...". En el caso del abstract no se admitirá el empleo de traductores automáticos por su pésima calidad.

4) Descriptores (español) / Keywords (inglés): Se deben exponer máximo 6 términos por cada versión idiomática relacionados directamente con el tema del trabajo. Será valorado positivamente el uso de las palabras claves expuestas en el Thesaurus de la UNESCO y en el de la propia revista.

5) Introducción: Deberá incluir una presentación breve del tema, la formulación del propósito u objetivo del estudio, el contexto de la problemática y la formulación del problema que se propone enfrentar, la presentación de la idea a defender, la justificación que explica la importancia, la actualidad y la pertinencia del estudio; el marco metodológico utilizado, y finalmente, una breve descripción de la estructura del documento. En la justificación es necesario utilizar citas bibliográficas así como la literatura más significativa y actual del tema a escala nacional e internacional.

6) Cuerpo o desarrollo del documento: Implica poner en práctica a lo largo de toda la exposición, una actitud crítica que deberá tender hacia la interpelación, a efectos de concitar la atención del tema y el problema tratados. El escritor deberá generar en el lector la capacidad de identificar la intención dialógica de la propuesta y potenciar en el una discusión abierta.

7) Conclusiones: Expone de manera objetiva los resultados y hallazgos; ofrece una visión de las implicaciones del trabajo, las limitaciones, la respuesta tentativa al problema, las relaciones con el objetivo de la investigación y las posibles líneas de continuidad (para cumplir con este objetivo se sugiere no incluir todos los resultados obtenidos en la investigación). Las conclusiones deberán ser debidamente justificadas de acuerdo con la investigación realizada. Las conclusiones podrán estar asociadas con las recomendaciones, evaluaciones, aplicaciones, sugerencias, nuevas relaciones e hipótesis aceptadas o rechazadas.

8) Bibliografía: Es el conjunto de obras utilizadas en la estructuración del texto científico. Deberá incluir únicamente la referencia de los trabajos utilizados en la investigación. Las referencias bibliográficas deberán ordenarse alfabéticamente y ajustarse a las normas internacionales APA, en su sexta edición.

3.2. Normas para las referencias

Publicaciones periódicas

Artículo de revista (un autor): Valdés-Pérez, D. (2016). Incidencia de las técnicas de gestión en la mejora de decisiones administrativas [Impact of Management Techniques on the Improvement of Administrative Decisions]. *Retos, 12*(6), 199-2013. https://doi.org/10.17163/ret.n12.2016.05

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 341-356.

Artículo de revista (hasta seis autores): Ospina, M.C., Alvarado, S.V., Fefferman, M., & Llanos, D. (2016). Introducción del dossier temático "Infancias y juventudes: violencias, conflictos, memorias y procesos de construcción de paz" [Introduction of the thematic dossier "Infancy and Youth: Violence, Conflicts, Memories and Peace Construction Processes"]. *Universitas, 25*(14), 91-95. https://doi.org/10.17163/uni.n25.%25x

Artículo de revista (más de seis autores): Smith, S.W., Smith, S.L. Pieper, K.M., Yoo, J.H., Ferrys, A.L., Downs, E.,... Bowden, B. (2006). Altruism on American Television: Examining the Amount of, and Context Surronding. Acts of Helping and Sharing. *Journal of Communication, 56*(4), 707-727. https://doi.org/10.1111/j.1460-2466.2006.00316.x

Artículo de revista (sin DOI): Rodríguez, A. (2007). Desde la promoción de salud mental hacia la promoción de salud: La concepción de lo comunitario en la implementación de proyectos sociales. *Alteridad, 2*(1), 28-40. (https://goo.gl/zDb3Me) (2017-01-29).

Libros y capítulos de libro

Libros completos: Cuéllar, J.C., & Moncada-Paredes, M.C. (2014). *El peso de la deuda externa ecuatoriana*. Quito: Abya-Yala.

Capítulos de libro: Zambrano-Quiñones, D. (2015). *El ecoturismo comunitario en Manglaralto y Colonche*. En V.H. Torres (Ed.), Alternativas de Vida: Trece experiencias de desarrollo endógeno en Ecuador (pp. 175-198). Quito: Abya-Yala.

Medios electrónicos

Pérez-Rodríguez, M.A., Ramírez, A., & García-Ruíz, R. (2015). La competencia mediática en educación infantil. Análisis del nivel de desarrollo en España. Universitas Psychologica, 14(2), 619-630. https://doi.org.10.11144/Javeriana.upsy14-2.cmei

Es prescriptivo que todas las citas que cuenten con DOI (Digital Object Identifier System) estén reflejadas en las Referencias (pueden obtenerse en http://goo.gl/gfruh1). Todas las revistas y libros que no tengan DOI deben aparecer con su link (en su versión on-line, en caso de que la tengan, acortada, mediante Bitly: https://bitly.com/ y fecha de consulta en el formato indicado.

Los artículos de revistas deben ser expuestos en idioma inglés, a excepción de aquellos que se encuentren en español e inglés, caso en el que se expondrá en ambos idiomas utilizando corchetes. Todas las direcciones web que se presenten tienen que ser acortadas en el manuscrito, a excepción de los DOI que deben ir en el formato indicado (https://doi.org/XXX).

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 341-356.

3.3. Epígrafes, tablas y gráficos

Los epígrafes del cuerpo del artículo se numerarán en arábigo. Irán sin caja completa de mayúsculas, ni subrayados, ni negritas. La numeración ha de ser como máximo de tres niveles: 1. / 1.1. / 1.1.1. Al final de cada epígrafe numerado se establecerá un retorno de carro.

Las tablas deben presentarse incluidas en el texto en formato Word según orden de aparición, numeradas en arábigo y subtituladas con la descripción del contenido.

Los gráficos o figuras se ajustarán al número mínimo necesario y se presentarán incorporadas al texto, según su orden de aparición, numeradas en arábigo y subtituladas con la descripción abreviada. Su calidad no debe ser inferior a 300 ppp, pudiendo ser necesario contar con el gráfico en formato TIFF, PNG o JPEG.

4. Proceso de envío

La recepción de artículos es permanente, sin embargo, considerando que la publicación de la Revista Sophia es semestral, el envío de los manuscritos deberá efectuarse al menos un período antes de la fecha estipulada en la Convocatoria correspondiente.

Los manuscritos deberán remitirse a través del sistema OJS (Open Journal System) de la revista, para lo cual es necesario que el autor se registre previamente en el espacio respectivo (ingrese en el siguiente link: http://sophia.ups.edu.ec/index.php/sophia/user/register, complemente el formulario y siga cada uno de los pasos que se sugieren).

Los cinco documentos que deben ser enviados son:

1. **Carta de Presentación.** Contiene la Declaración en la que se explica que el manuscrito enviado es una aportación original, que no ha sido enviado ni se encuentra en proceso de evaluación en otra revista. Consta la aceptación de las autorías firmantes, para que, en caso de ser procedente, luego del proceso de revisión del manuscrito, el equipo de redacción de Sophia, realice la introducción de cambios en el contenido, en aspectos formales y en el estilo del documento conforme a las exigencias de la Revista. Adicionalmente, la Carta de Presentación contiene el apartado de Cesión de DerEcos (cesión parcial de derEcos a la editorial) y la Declaración de conflicto de intereses, de acuerdo con las normas editoriales. Este documento deberá ser firmado y consignado a través del sistema OJS, en la sección: **"Ficheros complementarios"**.
2. **Cover Letter.** En la que se consigna la siguiente información:
   Tìtulo. En castellano en la primera línea, en letra Arial 14, con negrita y centrado, con un máximo de 85 caracteres con espacio. En inglés en la segunda línea, en letra Arial 14, en cursiva y con negrita.

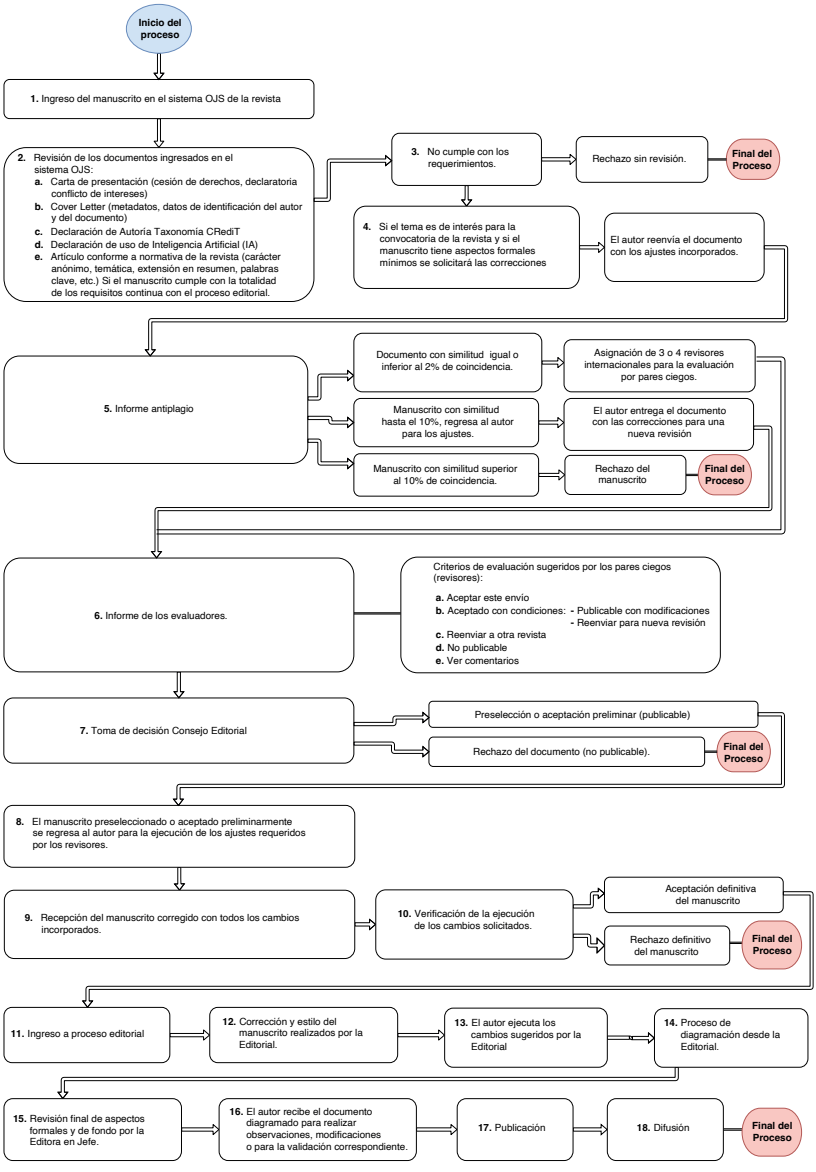
Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 341-356.

Nombres y apellidos completos de los autores. Organizados por orden de prelación, se aceptan como máximo 3 autores por original, aunque pudieren existir excepciones justificadas por el tema, su complejidad y extensión. Junto a cada uno de los nombres deberá incluirse, el nombre de la institución en la que trabaja así como la ciudad, el país, el correo electrónico y número de ORCID.
Resumen. Tendrá como extensión mínima 210 y máxima 220 palabras. El resumen describirá de forma concisa y en este orden: 1) Justificación del tema; 2) Objetivos; 3) Metodología; 4) Principales resultados; 5) Principales conclusiones. Ha de estar escrito de manera impersonal "El presente trabajo analiza...".
Abstract. Resumen con todos sus componentes, traducido al inglés y en letra cursiva. No utilizar sistemas de traducción automáticos.
Descriptores. Máximo 6 términos estandarizados preferiblemente de una sola palabra y del Thesaurus de la UNESCO y de la propia revista, separados por coma (,).
Keywords. Los 6 términos antes referidos traducidos al inglés y separados por coma (,). No utilizar sistemas de traducción automáticos.

3. **Declaración de Autoría (Taxonomía CRediT).** Aplicable para los casos de artículos elaborados por varios autores; detalla la contribución realizada por cada uno de los autores del documento presentado a Sophia, en concordancia con los 14 aspectos descritos según la Taxonomía CRediT. Este documento deberá ser firmado y consignado a través del sistema OJS, en la sección: **"Ficheros complementarios".** Es necesario utilizar el formato exigido por la Revista.
4. **Declaración de Uso de Inteligencia Artificial (IA).** Consiste en la Declaración formal que el/los autor/es realiza/n acerca del nivel de uso de inteligencia artificial (IA) en la elaboración, en partes o en componentes del documento presentado; explica de manera detallada, clara y precisa la forma en que dicha herramienta fue utilizada en el proceso y/o en la presentación de los resultados de la investigación. El documento debe estar respaldado con la/s firma/s de responsabilidad correspondientes y deberá ser consignado a través del sistema OJS de la Revista.
5. **Manuscrito** totalmente anonimizado, conforme a las normas referidas en precedencia.
   Todos los autores han de darse de alta, con sus créditos, en la plataforma OJS, si bien uno solo de ellos será el responsable de correspondencia. Ningún autor podrá enviar o tener en revisión dos manuscritos de forma simultánea, estimándose una carencia de cuatro números consecutivos (2 años).

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 341-356.

5. Proceso de evaluación del artículo



6. Intervalo de publicación

El intervalo comprendido entre la recepción y la publicación de un artículo es de 7 meses (210 días).

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 341-356.

Indications for External Reviewers of «Sophia»

The **Board of External Reviewers of «Sophia»** is an independent collegiate body whose purpose is to guarantee the excellence of this scientific publication, because the blind evaluation - based exclusively on the quality of the contents of the manuscripts and carried out by experts of recognized International prestige in the field - is, without a doubt, the best guarantee for the advancement of science and to preserve in this header an original and valuable scientific production.

To this end, the **Board of External Reviewers** is made up of several scholars and international scientists specialized in **Education**, essential to select the articles of the greatest impact and interest for the international scientific community. This in turn allows that all the articles selected to publish in «**Sophia**» have an academic endorsement and objectifiable reports on the originals.

Of course, all reviews in «**Sophia**» use the internationally standardized system of double-blind peer evaluation that guarantees the anonymity of manuscripts and reviewers. As a measure of transparency, the complete lists of reviewers are published on the official website of the journal (http://Sophia.ups.edu.ec/)

1. Criteria for acceptance/rejection of manuscript evaluation

The editorial team of «**Sophia**» selects those that are considered more qualified in the subject of the manuscript from the list of reviewers of the Board of Reviewers. While the publication requires the maximum collaboration of reviewers to expedite the evaluations and reports on each original, acceptance of the review must be linked to:

a. **Expertise**. Acceptance necessarily entails the possession of competences in the specific theme of the article to be evaluated.
b. **Availability**. Reviewing an original takes time and involves careful reflection on many aspects.
c. **Conflict of interests**. In case of identification of the authorship of the manuscript (despite their anonymity), excessive academic or family closeness to their authors, membership in the same University, Department, Research Group, Thematic Network, Research Projects, joint publications with authors... or any other type of connection or conflict / professional proximity; The reviewer must reject the publisher's invitation for review.
d. **Commitment of confidentiality.** Reception of a manuscript for evaluation requires the Reviewer to express a commitment of confidentiality, so that it cannot be divulged to a third party throughout the process.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 373-378.

In the event that the reviewer cannot carry out the activity for some of these reasons or other justifiable reasons, he/she must notify the publisher by the same route that he/she has received the invitation, specifying the reasons for rejection.

2. General criteria for the evaluation of manuscripts

a) Topic

In addition to being valuable and relevant to the scientific community, the topic that is presented in the original must be limited and specialized in time and space, without excessive localism.

b) Redaction

The critical assessment in the review report must be objectively written, providing content, quotes or references of interest to support its judgment.

c) Originality

As a fundamental criterion of quality, an article must be original, unpublished and suitable. In this sense, reviewers should answer these three questions in the evaluation:

- Is the article sufficiently novel and interesting to justify publication?
- Does it contribute anything to the knowledge canon?
- Is the research question relevant?

A quick literature search using repositories such as Web of Knowledge, Scopus and Google Scholar to see if the research has been previously covered, may be helpful.

d) Structure

Manuscripts that refer to «Sophia» must follow the IMRDC structure, except those that are literature reviews or specific studies. In this sense, the originals must contain summary, introduction, methodology, results, discussion and conclusion.

- The **title, abstract, and keywords** should accurately describe the content of the article.
- The **review of the literature** should summarize the state of the question of the most recent and adequate research for the presented work. It will be especially evaluated with criteria of suitability and that the references are to works of high impact - especially in WoS,

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 373-378.

Scopus, Scielo, etc. It should also include the general explanation of the study, its central objective and the followed methodological design.

- In case of research, in the **materials and methods**, the author must specify how the data, the process and the instruments used to respond to the hypothesis, the validation system, and all the information necessary to replicate the study are collected.
- **Results** must be clearly specified in logical sequence. It is important to check if the figures or charts presented are necessary or, if not, redundant with the content of the text.
- In the **discussion**, the data obtained should be interpreted in the light of the literature review. Authors should include here if their article supports or contradicts previous theories. The conclusions will summarize the advances that the research presents in the area of scientific knowledge, the future lines of research and the main difficulties or limitations for carrying out the research.
- **Language**: It will be positively assessed if the language used facilitates reading and is in favor of the clarity, simplicity, precision and transparency of the scientific language. The Reviewer should not proceed to correction, either in Spanish or English, but will inform the Editors of these grammatical or orthographical and typographical errors.
- Finally, a thorough **review of the references** is required in case any relevant work has been omitted. The references must be precise, citing within the logic of the subject at study, its main works as well as the documents that most resemble the work itself, as well as the latest research in the area.

3. Relevant valuation dimensions

For the case of empirical research articles**,** «**Sophia**» uses an evaluation matrix of each original that responds to the editorial criteria and to compliance with the publication guidelines. In this sense, the reviewers must attend to the qualitative-quantitative assessment of each of the aspects proposed in this matrix with criteria of objectivity, reasoning, logic and expertise.

If the original is a review of the literature (status of the matter) or other type of study (reports, proposals, experiences, among others), the Editorial Board will send to the reviewers a different matrix, including the characteristics of Structure of this type of originals:

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 373-378.

STUDIES, REPORTS, PROPOSALS AND REVIEW	
Valuable items	**Score**
01. Relevancy of the title (clarity, precision and with a maximum of 85 characters).	0/5
02. They summarize (In an alone paragraph and without epigraphs, minimum / minimal: 210-220 words).	0/5
03. Introduction (brief presentation of the topic; formulation of the problem; it designs to defending or hypothesis to demonstrating; I target; importance of the topic; current importance; methodology; structure of the document).	0/5
04. Review of the bibliographical foundation (Beside using current bibliography to consider the incorporation of Sophia's documents).	0/10
05. Structure and organization of the article (argumentative capabilities, coherence and scientific redaction).	0/10
06. Original contributions and contextualized analyses.	0/5
07. Conclusions that answer to the topic, to the problem and to the raised aim.	0/5
08. Citations and references of agreement to the regulation and to the format requested by the magazine (Any document and author who consists in the section of bibliography must consist in the body of story and viceversa).	0/5
Maximun total	50 points

RESEARCHES	
Valuable items	**Score**
01. Relevancy of the title (clarity, precision and with a maximum of 85 characters).	0/5
02. They summarize (In an alone paragraph and without epigraphs, minimum / minimal: 210-220 words).	0/5
03. Introduction (brief presentation of the topic; formulation of the problem; it designs to defending or hypothesis to demonstrating; I target; importance of the topic; current importance; methodology; structure of the document).	0/5
04. Review of the bibliographical foundation (Beside using current bibliography to consider the incorporation of Sophia's documents). Methodological rigorous and presentation of instruments of investigation.	0/10

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 373-378.

RESEARCHES	
Valuable items	**Score**
05. Structure and organization of the article (argumentative capabilities, coherence and scientific redaction). Analysis and results of investigation with logical sequence in the text. Presentation of tables and figures without duplicity of information.	0/10
06. Original contributions and contextualized analyses of the information.	0/5
07. Discussion, conclusions and advances that answer to the topic, to the problem and to the raised aim.	0/5
08. Citations and references of agreement to the regulation and to the format requested by the magazine (Any document and author who consists in the section of bibliography must consist in the body of story and vice versa).	0/5
Total	50 points

4. Ethical issues

a. **Plagiarism:** Although the journal uses plagiarism detection systems, if the reviewer suspects that an original is a substantial copy of another work, he must immediately inform the Editors citing the previous work in as much detail as possible.
b. **Fraud:** If there is real or remote suspicion that the results in an article are false or fraudulent, it is necessary to inform them to the Editors.
c. **Omitting the author declaration:** In the article, it is necessary to acknowledge the contributions made by each author according to their level of involvement.
d. **Conflicts of interest:** In order to ensure transparency and objectivity in the work, any potential conflict of interest that may influence the results or interpretation of the research must be declared.
e. **Ethical consent and respect for participants:** When the article involves human or animal subjects, the authors must have obtained the relevant ethical permissions and ensure that the research has been conducted in accordance with established ethical principles, respecting the privacy and well-being of the participants.
f. **Transparency in the use of artificial intelligence (AI):** In cases where AI has been used in the research, the authors must declare its use, clearly and precisely specifying how it has been employed, describing the algorithms, tools, and techniques used, as well as the

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 373-378.

data, parts, or sections developed with the support of the tool, following the applicable ethical guidelines.

g. **Data access and replicability:** The authors must ensure that the data used in the research is accessible for verification and replication, promoting transparency and reproducibility of the results.

5. Evaluation of the originals

After completing the quantitative and qualitative evaluation of the manuscript under review, the reviewer may propose recommendations aimed at improving the quality of the original text. The manuscript will be graded according to the following four options

1. **Accept this submission.** The topic, content, and structure align with the themes outlined in the call for papers and are related to the journal's research areas.
2. **Accepted with conditions.** The article is interesting; however, it does not meet some formal requirements set by the journal to proceed with the editorial process. It is necessary to clearly identify the components that need improvement, list the comments, and specify the paragraphs and pages where modifications are suggested. This criterion involves two aspects: a. Publishable with modifications; and b. Resubmit for further review.
3. **Submit to another journal.** This criterion applies when the topic is interesting, the document is well-structured, but it does not align with the nature and research areas of the journal.
4. **Not publishable.** The article is rejected due to the identified deficiencies, which are justified and reasoned with both qualitative and quantitative evaluation. If the quantitative evaluation scores less than 35 out of 50 points, the report must be detailed and explain the reasons for rejection.

All the above criteria include a comments section, represented by the phrase: See comments.

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 373-378.

Indicaciones para revisores externos de «Sophia»

El **Consejo de Revisores Externos de «Sophia»** es un órgano colegiado independiente cuyo fin es garantizar la excelencia de esta publicación científica, debido a que la evaluación ciega —basada exclusivamente en la calidad de los contenidos de los manuscritos y realizada por expertos de reconocido prestigio internacional en la materia— es la mejor garantía y, sin duda, el mejor aval para el avance de la ciencia y para preservar en esta cabecera una producción científica original y valiosa.

Para ello, el **Consejo de Revisores Externos** está conformado por diversos académicos y científicos internacionales especialistas en **Filosofía de la Educación**, esenciales para seleccionar los artículos de mayor impacto e interés para la comunidad científica internacional. Esto permite a su vez que todos los artículos seleccionados para publicar en «**Sophia**» cuenten con un aval académico e informes objetivables sobre los originales.

Por supuesto, todas las revisiones en «**Sophia**» emplean el sistema estandarizado internacionalmente de evaluación por pares con «doble ciego» (*doble-blind*) que garantiza el anonimato de los manuscritos y de los revisores de los mismos. Como medida de transparencia, anualmente se hacen públicos en la web oficial de la revista (http://Sophia.ups.edu.ec/) los listados completos de los revisores.

1. Criterios de aceptación/rechazo de evaluación manuscritos

El equipo editorial de «**Sophia**» selecciona del listado de evaluadores del Consejo de Revisores a aquellos que se estiman más cualificado en la temática del manuscrito. Si bien por parte de la publicación se pide la máxima colaboración de los revisores para agilizar las evaluaciones y los informes sobre cada original, la aceptación de la revisión ha de estar vinculada a:

a. **Experticia.** La aceptación conlleva necesariamente la posesión de competencias en la temática concreta del artículo a evaluar.
b. **Disponibilidad**. Revisar un original exige tiempo y conlleva reflexión concienzuda de muchos aspectos.
c. **Conflicto de intereses.** En caso de identificación de la autoría del manuscrito (a pesar de su anonimato), excesiva cercanía académica o familiar a sus autores, pertenencia a la misma Universidad, Departamento, Grupo de Investigación, Red Temática, Proyectos de Investigación, publicaciones conjuntas con los autores... o cualquier otro tipo de conexión o conflicto/cercanía profesional; el revisor debe rechazar la invitación del editor para su revisión.
d. **Compromiso de confidencialidad**. La recepción de un manuscrito para su evaluación exige del Revisor un compromiso expreso de

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 357-362.

confidencialidad, de manera que éste no puede, durante todo el proceso, ser divulgado a un tercero.

En caso que el revisor no pueda llevar a cabo la actividad por algunos de estos motivos u otros justificables, debe notificarlo al editor por la misma vía que ha recibido la invitación, especificando los motivos de rechazo.

2. Criterios generales de evaluación de manuscritos

a) Tema

La temática que se plantea en el original, además de ser valiosa y relevante para la comunidad científica, ha de ser limitada y especializada en tiempo y espacio, sin llegar al excesivo localismo.

b) Redacción

La valoración crítica en el informe de revisión ha de estar redactada de forma objetiva, aportando contenido, citas o referencias de interés para argumentar su juicio.

c) Originalidad

Como criterio de calidad fundamental, un artículo debe ser original, inédito e idóneo. En este sentido, los revisores deben responder a estas tres preguntas en la evaluación:

- ¿Es el artículo suficientemente novedoso e interesante para justificar su publicación?
- ¿Aporta algo al canon del conocimiento?
- ¿Es relevante la pregunta de investigación?

Una búsqueda rápida de literatura utilizando repositorios tales como Web of Knowledge, Scopus y Google Scholar para ver si la investigación ha sido cubierta previamente puede ser de utilidad.

d) Estructura

Los manuscritos que se remiten a «**Sophia**» deben seguir la estructura señalada en las normas de publicación tanto para las investigaciones empíricas como para revisiones de la literatura o estudios específicos. En este sentido, los originales han de contener resumen, introducción, metodología, resultados, discusión y conclusión.

- El título, el resumen y las palabras clave han de describir exactamente el contenido del artículo.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 357-362.

- La revisión de la literatura debe resumir el estado de la cuestión de las investigaciones más recientes y adecuadas para el trabajo presentado. Se valorará especialmente con criterios de idoneidad y que las referencias sean a trabajos de alto impacto —especialmente en WoS, Scopus, Scielo, etc. Debe incluir además la explicación general del estudio, su objetivo central y el diseño metodológico seguido.
- En caso de investigaciones, en los materiales y métodos, el autor debe precisar cómo se recopilan los datos, el proceso y los instrumentos usados para responder a las hipótesis, el sistema de validación, y toda la información necesaria para replicar el estudio.
- En los resultados se deben especificar claramente los hallazgos en secuencia lógica. Es importante revisar si las tablas o cuadros presentados son necesarios o, caso contrario, redundantes con el contenido del texto.
- En la discusión se deben interpretar los datos obtenidos a la luz de la revisión de la literatura. Los autores deberán incluir aquí si su artículo apoya o contradice las teorías previas. Las conclusiones resumirán los avances que la investigación plantea en el área del conocimiento científico, las futuras líneas de investigación y las principales dificultades o limitaciones para la realización de la investigación.
- Idioma: Se valorará positivamente si el idioma utilizado facilita la lectura y va en favor de la claridad, sencillez, precisión y transparencia del lenguaje científico. El Revisor no debe proceder a corrección, ya sea en español o inglés, sino que informará a los Editores de estos errores gramaticales u ortotipográficos.
- Finalmente, se requiere una profunda revisión de las referencias por si se hubiera omitido alguna obra relevante. Las referencias han de ser precisas, citando en la lógica de la temática a estudiar, sus principales obras así como los documentos que más se asemejen al propio trabajo, así como las últimas investigaciones en el área.

3. Dimensiones relevantes de valoración

Para el caso de artículos de investigaciones empíricas, «**Sophia**» utiliza una matriz de evaluación de cada original que responde a los criterios editoriales y al cumplimiento de la normativa de la publicación. En este sentido los revisores deberán atender a la valoración cuali-cuantitativa de cada uno de los aspectos propuestos en esta matriz con criterios de objetividad, razonamiento, lógica y experticia.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 357-362.

Para el caso de artículos reflexivos, estudios, revisiones de literatura (estado de la cuestión) u otro tipo de estudio (informes, propuestas, experiencias, entre otras), el Consejo Editorial remitirá a los revisores una matriz distinta, comprendiendo las características propias de estructura de este tipo de originales:

ESTUDIOS, PROPUESTAS, INFORMES Y EXPERIENCIAS	
Ítems valorables	**Puntaje**
01. Pertinencia del título (claridad, precisión y con un máximo de 85 caracteres).	0/5
02. Resumen (En un solo párrafo y sin epígrafes, mínimo/máximo: 210-220 palabras).	0/5
03. Introducción (breve presentación del tema; formulación del problema; idea a defender o hipótesis a demostrar; objetivo; importancia del tema; actualidad; metodología; estructura del documento).	0/5
04. Revisión de la fundamentación bibliográfica (Además de usar bibliografía actual considerar la inclusión de documentos de Sophia).	0/10
05. Estructura y organización del artículo (capacidad argumentativa, coherencia y redacción científica).	0/10
06. Aportaciones originales y análisis contextualizados.	0/5
07. Conclusiones que respondan al tema, al problema y al objetivo planteado.	0/5
0.8. Citaciones y referencias de acuerdo a la normativa y al formato solicitado por la revista (Todo documento y autor que conste en la sección de bibliografía debe constar en el cuerpo del artículo y viceversa).	0/5
Total máximo	50 puntos

INVESTIGACIONES	
Ítems valorables	**Puntaje**
01. Pertinencia del título (claridad, precisión y con un máximo de 85 caracteres)	0/5
02. Resumen (En un solo párrafo y sin epígrafes, mínimo/máximo: 210-220 palabras).	0/5
03. Introducción (breve presentación del tema; formulación del problema; idea a defender o hipótesis a demostrar; objetivo; importancia del tema; actualidad; metodología; estructura del documento).	0/5

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 357-362.

INVESTIGACIONES	
Ítems valorables	**Puntaje**
04. Revisión de la fundamentación bibliográfica (Además de usar bibliografía actual considerar la inclusión de documentos de Sophia). Rigor metodológico y presentación de instrumentos de investigación.	0/10
05. Estructura y organización del artículo (capacidad argumentativa, coherencia y redacción científica). Análisis y resultados de investigación con secuencia lógica en el texto. Presentación de tablas y figuras sin duplicidad de datos.	0/10
0.6. Aportaciones originales y análisis contextualizados de los datos.	0/5
0.7. Discusión, conclusiones y avances que respondan al tema, al problema y al objetivo planteado.	0/5
0.8. Citaciones y referencias de acuerdo a la normativa y al formato solicitado por la revista (Todo documento y autor que conste en la sección de bibliografía debe constar en el cuerpo del artículo y viceversa).	0/5
Total máximo	50 puntos

4. Cuestiones éticas

a. **Plagio:** Aunque la revista utiliza sistemas de detección de plagio, si el revisor sospechare que un original es una copia sustancial de otra obra, ha de informar de inmediato a los Editores citando la obra anterior con tanto detalle cómo le sea posible.
b. **Fraude:** Si hay sospecha real o remota de que los resultados en un artículo son falsos o fraudulentos, es necesario informar de ellos a los Editores.
c. **Omitir declaración de autoría:** En el artículo, es necesario reconocer las contribuciones realizadas por cada uno de los autores de acuerdo a su grado de participación.
d. **Conflictos de interés:** Con la finalidad de asegurar la transparencia y objetividad en el trabajo, es preciso declarar cualquier posible conflicto de interés que pueda influir en los resultados o la interpretación de la investigación.
e. **Consentimiento ético y respeto por los participantes:** Cuando el artículo involucre a sujetos humanos o animales, los autores deben haber obtenido los correspondientes permisos éticos y asegurarse de que la investigación se haya realizado en concordancia con los principios éticos establecidos, respetando la privacidad y el bienestar de los participantes.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 357-362.

f. **Transparentar el uso de inteligencia artificial (IA):** En el caso de que en la investigación se haya utilizado IA, los autores deben declarar su empleo especificando con claridad y precisión la manera en que ha sido utilizada, describiendo los algoritmos, las herramientas y las técnicas empleadas, así como los datos, las partes o secciones elaboradas con el apoyo de la herramienta siguiendo las directrices éticas aplicables.
g. **Acceso a los datos y replicabilidad:** Los autores deben garantizar que los datos utilizados en la investigación sean accesibles para su verificación y replicación, promoviendo la transparencia y la reproducibilidad de los resultados.

5. Evaluación de los originales

Luego de completar la evaluación cuanti-cualitativa del manuscrito en revisión, el revisor podrá proponer recomendaciones destinadas a mejorar la calidad del texto original. La calificación del manuscrito se realizará conforme a las siguientes cuatro opciones:

1. **Aceptar este envío.** El tema, contenido y estructura responden a la temática prevista en la convocatoria y están vinculados con las líneas de investigación de la Revista.
2. **Aceptado con condiciones.** El artículo es interesante, sin embargo, no cumple con algunos aspectos de carácter formal exigidos por la revista para avanzar con el proceso editorial. Es preciso identificar con claridad los componentes que deben ser mejorados, debe enumerar los comentarios, especificar los párrafos y páginas en las que se sugiere las modificaciones. Este criterio, implica dos aspectos: a. Publicable con modificaciones; y, b. Reenviar para nueva revisión.
3. **Reenviar a otra revista.** La aplicación de este criterio aplica cuando el tema es interesante, el documento se encuentra bien estructurado, pero no responde a la naturaleza y líneas de investigación de la revista.
4. **No publicable.** El artículo es rechazado debido a las deficiencias detectadas, justificadas y razonadas con valoración cualitativa y cuantitativa. Si en la evaluación cuantitativa obtiene una valoración menos de 35 de los 50 puntos, el informe deberá ser detallado y explicativo de las razones del rechazo.

Todos los criterios anteriores contienen una sección de comentarios, representada por la expresión: Ver comentarios.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 357-362.

Protocol of Manuscript Evaluation for External Reviewers

Instructions

- The fulfillment of each one of the articles will be valued in agreement to the following protocol.
- The total sum of the articles will determine the approval or rejection of the article.
- The minimal puntaje in order that the article is approved will be of 44/50.

Article Details		
Date of submission for evaluation:	Date of return of evaluation:	Article code:
Title of the article to be evaluated:		
SECTION: REPORTS, STUDIES, PROPOSALS AND REVIEWS		
01.- Relevancy of the title (clarity, precision and with a maximum of 85 characters)	Mandatory comments:	
	Value from 0 to 5	
02.- They summarize (In an alone paragraph and without epigraphs, minimum / minimal: 210-220 words).	Mandatory comments:	
	Value from 0 to 5	
03.- Introduction (brief presentation of the topic; formulation of the problem; it designs to defending or hypothesis to demonstrating; I target; importance of the topic; current importance; methodology; structure of the document)	Mandatory comments:	
	Value from 0 to 5	
04.- Review of the bibliographical foundation (Beside using current bibliography to consider the incorporation of Sophia's documents).	Mandatory comments:	
	Value from 0 to 10	

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 363-366.

05.- Structure and organization of the article (argumentative capabilities, coherence and scientific redaction)	Mandatory comments:	
	Value from 0 to 10	
06.- Original contributions and contextualized analyses	Mandatory comments:	
	Value from 0 to 5	
07.- Conclusions that answer to the topic, to the problem and to the raised aim	Mandatory comments:	
	Value from 0 to 5	
08.- Citations and references of agreement to the regulation and to the format requested by the magazine (Any document and author who consists in the section of bibliography must consist in the body of story and vice versa)	Mandatory comments:	
	Value from 0 to 5	
OBTAINED PUNCTUATION	Of the total of 50 predictable points, this assessor grants:	

REDACTED OPINION More detailed if the work does not get 44 points, to inform the autor (s). This text is sent verbatim to the autor (s) amonymously	

RECOMMENDATION ON HIS PUBLICATION IN SOPHIA			
Validation criteria	**Result**		
	Yes	**Yes, with conditions**	**No**
01. Widely recommended			
02. Recommended only if his quality is improved attending to the totality of the suggestions realized by the revisers			
03. His publication is not recommended			
PROPOSED CHANGES (In case of "Yes, with conditions")			

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 363-366.

Protocolo de evaluación de manuscritos para revisores externos

Instrucciones

- El cumplimiento de cada uno de los ítems será valorado de acuerdo al siguiente protocolo.
- La suma total de los ítems determinará la aprobación o rechazo del artículo. El puntaje mínimo para que el artículo sea aprobado será de 44/50.

Datos del artículo		
Fecha envío evaluación:	Fecha devolución evaluación:	Código artículo:
Título del artículo a evaluar:		
SECCIÓN: ESTUDIOS, PROPUESTAS, INFORMES Y REVISIONES		
01.- Pertinencia del título (claridad, precisión y con un máximo de 85 caracteres)	Comentarios obligatorios:	
	Valore de 0 a 5	
02.- Resumen (En un solo párrafo y sin epígrafes, mínimo/máximo: 210-220 palabras).	Comentarios obligatorios:	
	Valore de 0 a 5	
03.- Introducción (breve presentación del tema; formulación del problema; idea a defender o hipótesis a demostrar; objetivo; importancia del tema; actualidad; metodología; estructura del documento)	Comentarios obligatorios:	
	Valore de 0 a 5	
04.- Revisión de la fundamentación bibliográfica (Además de usar bibliografía actual considerar la inclusión de documentos de Sophia)	Comentarios obligatorios:	
	Valore de 0 a 10	
05.- Estructura y organización del artículo (capacidad argumentativa, coherencia y redacción científica)	Comentarios obligatorios	
	Valore de 0 a 10	

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 363-366.

06.- Aportaciones originales y análisis contextualizados	Comentarios obligatorios:	
	Valore de 0 a 5	
07.- Conclusiones que respondan al tema, al problema y al objetivo planteado	Comentarios obligatorios:	
	Valore de 0 a 5	
08.- Citaciones y referencias de acuerdo a la normativa y al formato solicitado por la revista (Todo documento y autor que conste en la sección de bibliografía debe constar en el cuerpo del artículo y viceversa)	Comentarios obligatorios:	
	Valore de 0 a 5	
PUNTUACIÓN OBTENIDA	Del total de 50 puntos previsibles, este evaluador otorga:	

OPINIÓN REDACTADA (Más detallada si el trabajo no tiene 44 puntos, para informar al autor/es) Este texto se remite textualmente al/los autor/es de forma anónima			
RECOMENDACIÓN SOBRE SU PUBLICACIÓN EN SOPHIA			
PUBLICABLE	**Resultado**		
	SI	**Sí, con condiciones**	**NO**
01. Ampliamente recomendado			
02. Recomendado sólo si se mejora su calidad atendiendo a la totalidad de las sugerencias realizadas por los revisores			
03. No se recomienda su publicación			
MODIFICACIONES PROPUESTAS (En caso de «Sí, con condiciones»)			

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 363-366.

Checklist prior to sending the manuscript

1. CHECK OF THE MANUSCRIPT, PRIOR TO SENDING	
To facilitate the process of evaluation of the manuscript and to accelerate the report of its possible publication, a final self-review of the manuscript is advised, checking the following questions.	
COVER LETTER	
Title of the manuscript in spanish (maximum 85 characters).	
Title of the manuscript in english (maximum 85 characters).	
The two versions of the title of the manuscript are concise, informative and collect as many identifiable terms as possible.	
The abstract in spanish is included, in a single paragraph and without epigraphs (minimum / maximum: 210/220 words).	
The abstract in english is included, in a single paragraph and without epigraphs (minimum / maximum: 210-220 words).	
Abstracts in spanish and english respond in order to the following issues: justification of the subject, objectives, study methodology, results and conclusions.	
It includes 6 descriptors (in english and spanish) (only simple words, not phrases or combinations of words), with the most significant terms, and if possible standardized.	
The texts in english (title, abstract and descriptors) have been written or verified by an official translator or expert in this language (The use of automatic translators is prohibited).	
All the identification data of the authors are included in the order stipulated in the norms: identification and correspondence data, professional filiations, last academic degree...	
The first and last name of the authors has been normalized.	
Each author is identified with their ORCID code.	
The maximum number of authors is three, with the exception of those works that justify a higher but limited number of authors	
The author(s) have duly signed the letter of presentation of the article, which includes the partial transfer of rights and the declaration of conflict of interest.	
MANUSCRIPT	
It includes title of the manuscript, abstract, and keywords. All in spanish and english.	

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 367-374.

An introduction is included that in order contains: brief presentation of the subject; problem formulation; Idea to defend or hypothesis to prove; objective; Importance of the theme; relevance; methodology; structure of the document.	
The text is within the minimum and maximum extension: In the Review sections: 10,000/11,000 words of text (without including the references). In the research section: 8,000/9,500 words of text (without including the references). Reports, Studies: 8,000/9,500 words of text (without including the references).	
In case of research, the manuscript responds to the structure required in the guidelines (IMRDC).	
In the case of a report, study or review, the manuscript respects the minimum structure required by the guidelines.	
The review work includes three citations from three previous issues of Sophia Journal.	
The manuscript explicitly cites and cites the used sources and materials.	
The methodology described for the research work is clear and concise, allowing its replication, if necessary, by other experts.	
The conclusions follow on objective and problem raised are supported by the results obtained and presented in the form of a synthesis.	
If statistical analyzes have been used, they have been reviewed/contrasted by an expert.	
The citations in the text are strictly in accordance with the APA 6 regulations, reflected in the instructions.	
In case of use of final notes, it has been verified that these are descriptive and cannot be integrated into the general citation system. Footnotes are not acceptable.	
The final references have been rigorously reviewed and only those that have been cited in the text are included.	
The final references conform in style and format to the international standards used in Sophia.	
The number of references is according to the theoretical basis of the study carried out	
DOIs have been included in all References that carry it in the following format: doi: https://doi.org/XXXXXX	
All web addresses of references have been shortened with Google Url Shortner	

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 367-374.

If figures and charts are included, they should provide additional and not repeated information in the text. Their graphic quality has been verified.	
The number of charts and / or figures does not exceed 6	
If the case, financial support is declared.	
FORMAL ASPECTS	
The rules have been strictly observed in the use of bold, capital letters, italics and underlines.	
Arial font, size 12 has been used.	
A single line spacing (1) has been used without tab.	
The epigraphs have been properly and hierarchically numbered in Arabic.	
Double spaces have been deleted.	
The typographic quotes « » (with alt + 174 and alt + 175 for opening and closing) have been used.	
Word dictionary for surface spelling has been used.	
The text has been supervised by external staff to ensure grammar and style.	
PRESENTATION	
The signed **Letter of Introduction or Presentation** is attached, containing a Declaration that explains the originality of the manuscript; the authorization for the journal's editorial team to make necessary changes to the content, formal aspects, and style of the document; the Rights Transfer and the Conflict of Interest Declaration.	
The attached Cover Letter identifies the section of the journal to which the manuscript is submitted, includes informed consent for experimentation (if applicable); provides the article title in both Spanish and English, as required by the journal; details the complete identification information for each author; includes an abstract of at least 210 words and no more than 220 words; provides an abstract in English with a minimum of 200 words and a maximum of 210 words; does not use automatic translation systems; includes 6 keywords in Spanish and 6 keywords in English, separated by commas, in accordance with the UNESCO Thesaurus and the Journal's Thesaurus; and declares any financial support for the research (optional).	
The CRediT Author Statement clearly and accurately explains the contributions made by each of the article's authors and includes the responsibility signatures.	
The Artificial Intelligence Use Statement contains complete, clear, and precise information regarding its presentation	

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The manuscript is uploaded to the platform in Word format and without authors identification	
ANNEXED DOCUMENTS	
The five attached documents are: Presentation, Cover Letter, CRediT Author Statement, Artificial Intelligence (AI) Use Statement, and the article in Word format	
The accompanying documents and annexes have been published with Figshare.	

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 367-374.

Chequeo previo al envío del manuscrito

1. CHEQUEO DEL MANUSCRITO, PREVIO AL ENVÍO	
Para facilitar el proceso de evaluación del manuscrito y acelerar el informe de su posible publicación, se aconseja una autorevisión final del manuscrito, comprobando las siguientes cuestiones.	
DOCUMENTO PORTADA (Cover Letter)	
Se incluye título del manuscrito en español (máximo 85 caracteres).	
Se incluye título del manuscrito en inglés (máximo 85 caracteres).	
Las dos versiones del título del manuscrito son concisas, informativas y recogen el mayor número de términos identificativos posibles.	
Se incluye resumen en español, en un solo párrafo y sin epígrafes (mínimo/máximo: 210/220 palabras).	
Se incluye abstract en inglés, en un solo párrafo y sin epígrafes (mínimo/máximo 210-220 palabras).	
Los resúmenes en español e inglés responden ordenadamente a las siguientes cuestiones: justificación del tema, objetivos, metodología del estudio, resultados y conclusiones.	
Se incluyen 6 descriptores (en español e inglés) (sólo palabras simples, no sintagmas o combinaciones de palabras), con los términos más significativos, y a ser posibles estandarizados.	
Los textos en inglés (título, resumen y descriptores) han sido redactados o verificados por un traductor oficial o persona experta en este idioma (Se prohíbe el uso de traductores automáticos).	
Se incluyen todos los datos de identificación de los autores en el orden estipulado en la normativa: datos de identificación y correspondencia, filiaciones profesionales, último grado académico.	
Se ha normalizado el nombre y apellido de los autores.	
Cada autor está identificado con su código ORCID.	
El número máximo de autores es tres, a excepción de aquellos trabajos que justifiquen un número mayor limitado.	
El autor/es ha firmado debidamente la carta de presentación del artículo, en la que consta la cesión parcial de derEcos y la declaración de conflicto de intereses.	
MANUSCRITO	
Se incluye título del manuscrito en español, inglés, resumen, abstract, descriptores y keywords	

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 367-374.

Se incluye una introducción que en orden contiene: breve presentación del tema; formulación del problema; idea a defender o hipótesis a demostrar; objetivo; importancia del tema; actualidad; metodología; estructura del documento.	
El trabajo respeta la extensión mínima y máxima permitidas: Sección de Revisiones: 10.000/11.000 palabras de texto (sin incluir las referencias). Investigaciones: 8.000/9.500 palabras de texto (sin incluir las referencias). Informes, Estudios: 8.000/9.500 palabras de texto (sin incluir las referencias).	
En caso de investigación, el manuscrito responde a la estructura exigida en las normas (IMRDC).	
Si se trata de un informe, estudio o revisión, el manuscrito respeta la estructura mínima exigida en las normas.	
En los trabajos de revisión se incluyen tres citas de tres números anteriores de la Revista Sophia.	
El manuscrito explicita y cita correctamente las fuentes y materiales empleados.	
La metodología descrita, para los trabajos de investigación, es clara y concisa, permitiendo su replicación, en caso necesario, por otros expertos.	
Las conclusiones responden al objetivo y al problema planteados, se apoyan en los resultados obtenidos y se presentan en forma de síntesis.	
Si se han utilizado análisis estadísticos, éstos han sido revisados/contrastados por algún experto.	
Las citas en el texto se ajustan estrictamente a la normativa APA 6, reflejadas en las instrucciones.	
En caso de uso de notas finales, se ha comprobado que éstas son descriptivas y no pueden integrarse en el sistema de citación general. No se aceptan notas a pie de página.	
Se han revisado rigurosamente las referencias finales y se incluyen solo aquéllas que han sido citadas en el texto.	
Las referencias finales se ajustan en estilo y formato a las normas internacionales utilizadas en Sophia.	
El número de referencias está de acuerdo a la fundamentación teórica del estudio realizado	
Se han incluido los DOI en todas las Referencias que lo lleven con el siguiente formato: doi: https://doi.org/XXXXXX	
Todas las direcciones web de las referencias han sido acortadas con Google Url Shortner	

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 367-374.

Si se incluyen figuras y tablas éstas deben aportar información adicional y no repetida en el texto. Su calidad gráfica se ha verificado.	
El número de tablas y/o figuras no sobrepasa las 6.	
En su caso, se declaran los apoyos y/o soportes financieros.	
ASPECTOS FORMALES	
Se ha respetado rigurosamente la normativa en el uso de negritas, mayúsculas, cursivas y subrayados.	
Se ha utilizado letra Arial, tamaño 12.	
Se ha usado un interlineado sencillo (1) y sin tabulaciones.	
Se han numerado los epígrafes en arábigo de forma adecuada y jerárquicamente.	
Se han suprimido los dobles espacios.	
Se han empleado las comillas tipográficas « » (con alt+174 y alt+175 para apertura y cierre).	
Se ha utilizado el diccionario de Word para corrección ortográfica superficial.	
Se ha supervisado el trabajo por personal externo para garantizar la gramática y el estilo.	
PRESENTACIÓN	
Se adjunta la **Carta de Presentación** firmada por todos los autores, contiene Declaración que explica la originalidad del manuscrito; la autorización para que la redacción de la revista realice la introducción de cambios necesarios en el contenido, en aspectos formales y en el estilo del documento; la *Cesión de DerEcos y la Declaración de conflicto de intereses.*	
Se adjunta la **Cover Letter** que identifica la sección de la revista a la que se dirige el documento, el consentimiento informado de experimentación (si el caso lo amerita); contiene el título del artículo en español y en inglés con las características exigidas por la revista, detalla los datos completos de identificación de cada uno de los autores; presenta el resumen mínimo 210 y máximo 220 palabras; contiene el abstract con mínimo 200 y máximo 210 palabras; no utiliza sistemas de traducción automáticos; presenta 6 palabras clave y 6 keywords, separadas por coma, conforme al Thesaurus de la UNESCO y al Thesaurus de la Revista; declara el apoyo y soporte financiero de la investigación (opcional).	
La **Declaración de Autoría CRediT** explica con claridad y precisión las contribuciones realizadas por cada uno de los autores del artículo y contiene las firmas de responsabilidad.	
La Declaración de Uso de Inteligencia Artificial, contiene la información completa, clara y precisa en lo que amerita a su presentación.	

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 367-374.

El manuscrito se sube a la plataforma en formato Word y sin identificación de autores.	
DOCUMENTOS ANEXOS	
Se adjuntan los cinco documentos anexos: Cover Letter; Carta de presentación; Declaración de Autoría CRediT; Declaración de uso de Inteligencia Artificial (IA) y el artículo en versión Word	
Los documentos complementarios y anexos han sido publicados con Figshare.	

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 367-374.

Cover Letter

Section (Mark)
Monographic Dossier ___
Miscellaneous ___

Title in Spanish: Arial 14 bold and centered.
Maximum 85 characters with spaces
Title in English: Arial 14 cursive. Maximum 85 characters with spaces

Name author 1 (standardized)
Professional category, Institution, Country
Institutional email
ORCID

Name author 2 (standardized)
Professional category, Institution, Country
Institutional email
ORCID

Name author 3 (standardized)
Professional category, Institution, Country
Institutional email
ORCID

Abstract (Spanish)

Minimum 210 and maximum 220 words. It must include 1) Justification of the topic; 2) Objectives; 3) Methodology; 4) Main results; 5) Main conclusions. It must be impersonally written "The present paper analyzes..."

Abstract (English)

Minimum 200 and maximum 210 words. It must include 1) Justification of the topic; 2) Objectives; 3) Methodology; 4) Main results; 5) Main conclusions. It must be impersonally written "The present paper analyzes..." Do not use automatic translation systems.

Keywords (Spanish)

6 standardized terms preferably of a single word and of the UNESCO Thesaurus separated by commas (,).

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 375-378.

Keywords

The 6 terms referred to in English separated by commas (,). Do not use automatic translation systems.

Financial Support of Research (optional)

Entity:
Country:
City:
Subsidized project:
Code of the project:

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 375-378.

Cover Letter

Sección (Marcar)
Dossier Monográfico ___
Miscelánea ___

Título en español: Arial 14 negrita y centrado.
Máximo 85 caracteres con espacios
Title in English: Arial 14 cursiva. Máximo 85 caracteres con espacios

Nombre autor 1 (estandarizado)
Categoría profesional, Institución, País
Correo electrónico institucional
ORCID

Nombre autor 2 (estandarizado)
Categoría profesional, Institución, País
Correo electrónico institucional
ORCID

Nombre autor 3 (estandarizado)
Categoría profesional, Institución, País
Correo electrónico institucional
ORCID

Resumen

Mínimo 210 y máximo 220 palabras. Debe incluir 1) Justificación del tema; 2) Objetivos; 3) Metodología; 4) Principales resultados; 5) Principales conclusiones. Ha de estar escrito de manera impersonal "El presente trabajo analiza..."

Abstract

Mínimo 200 y máximo 210 palabras cursiva. Debe incluir 1) Justificación del tema; 2) Objetivos; 3) Metodología; 4) Principales resultados; 5) Principales conclusiones. Ha de estar escrito de manera impersonal "El presente trabajo analiza..." No utilizar sistemas de traducción automáticos.

Descriptores

6 términos estandarizados preferiblemente de una sola palabra y del Thesaurus de la UNESCO separados por coma (,).

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 375-378.

Keywords

Los 6 términos referidos en inglés separados por coma (,). No utilizar sistemas de traducción automáticos.

Apoyos y soporte financiero de la investigación (opcional)

Entidad:
País:
Ciudad:
Proyecto subvencionado:
Código de proyecto:

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 375-378.

PRESENTATION
Letter of introduction

Mr. Editor of «Sophia»

Having read the regulations of the journal «Sophia» and analyzed its coverage, thematic area and approach, I consider that this journal is the ideal one for the dissemination of the work that I hereby attach, for which I beg you to be submitted for consideration for publication. The original has the following title "_____", whose authorship corresponds to _____.

The authors (s) certify that this work has not been published, nor is it under consideration for publication in any other journal or editorial work.

The author (s) are responsible for their content and have contributed to the conception, design and completion of the work, analysis and interpretation of data, and to have participated in the writing of the text and its revisions, as well as in the approval of the version which is finally referred to as an attachment.

Changes to the content are accepted if they occur after the review process, and also changes in the style of the manuscript by the editorial process of «Sophia».

Transfer of Copyright and Declaration of Conflict of Interest

The Abya-Yala Publishing House (publishing house of the works of the *Universidad Politécnica Salesiana* of Ecuador) preserves the copyrights of the published works and will favor the reuse of the same. The works are published in the electronic edition of the journal under a Creative Commons Attribution / Noncommercial-No Derivative Works 3.0 Ecuador license: they can be copied, used, disseminated, transmitted and publicly displayed.

The undersigned author partially transfers the copyrights of this work to the *Abya-Yala Publishing House* (Ecuador) (RUC: 1790747123001), for the printed editions.

It is also declared that they have respected the ethical principles of research and are free from any conflict of interest.

In ____(city), by the____ days of the month of _____ of 202_

Signed. (By the author or in the case, all the authors)

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Author first and last name
Identification document

_____
Signature

Author first and last name
Identification document

_____
Signature

Author first and last name
Identification document

_____
Signature

Note: Once saved the completed and signed document, it must be register through the OJS system in the section "Complementary Files".

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 379-382.

PRESENTACIÓN
Carta de Presentación

Sr. Editor de «Sophia»

Leída la normativa de la revista «Sophia» y analizada su cobertura, área temática y enfoque, considero que esta revista es la idónea para la difusión del trabajo que le adjunto, por lo que le ruego sea sometida a la consideración para su publicación. El original lleva por título "_____", cuya autoría corresponde a _____.

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Announcements 2025-2030 / *Convocatorias 2025-2030*

Call for papers 2024-2030

Sophia 39
Philosophy in times of digitalization

Lines of research:

- Philosophy of educational technology
- Philosophy of education in the digital age
- Philosophy of artificial intelligence in the digital era
- Meaning, significance, and purpose of artificial intelligence in education
- Artificial intelligence as a means of surpassing human intelligence
- Virtual assistants in education
- Philosophical currents underpinning education in the digital age
- The role of teachers and the automation of educational processes
- Reflections on education through virtual methodology
- Teachers as digital immigrants
- Hybrid identity and mobile applications in learning

Article contributions: We welcome articles from prominent representatives in the field of philosophy, addressing the central theme and its implications in the philosophy of education, psychology, pedagogy, or other disciplines.

Manuscript submission deadline: December 15, 2024
Publication date of this edition: July 15, 2025

Sophia 40
Philosophy in the education of principles and values

Lines of research:

- Philosophy of values and their implications in education
- Knowledge of moral virtues
- Didactics of ethics
- Didactics of axiology
- Discourse as an ethical practice
- Education in ethical, political, civic, and religious values
- Philosophy of education based on axiology

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- Freedom, justice, and democracy in education
- Onto-anthropological aspects in values education
- Importance of vocation and peaceful coexistence in the educational environment
- Philosophical currents contributing to values education
- Teaching professional ethics
- Responsibility of professionals in the pursuit and communication of truth
- Ethical dilemmas related to truth in various professions
- Ethical dilemmas related to the use of technology and digital media

Article Contributions: We welcome articles from prominent representatives in the field of philosophy, addressing the central theme and its implications in the philosophy of education, psychology, pedagogy, or other disciplines.

Manuscript submission deadline: July 15, 2025
Publication date of this edition: January 15, 2026

Sophia 41
Fundamental categories for understanding the philosophy of education in contemporary society

Lines of research:

- Educational theory
- Ontic and ontological categories in the philosophy of education
- Critical theory of education
- Paradoxes of critical thinking and educational reality
- Nature and philosophy of learning
- Critical perspective on educational methodology and innovation
- Critical pedagogies and methodologies
- Self-concept and metacognitive strategies
- Contributions of formal logic, modal logic, and dialectical logic to understanding the philosophy of education

Article Contributions: We welcome articles from prominent representatives in the field of philosophy, addressing the central theme and its implications in psychology, pedagogy, or other disciplines.

Manuscript Submission Deadline: December 15, 2025
Publication Date of This Edition: July 15, 2026

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 393-412.

Sophia 42
Philosophy in media communication and digital media in education

Lines of research:

- Reflections on media education
- Truthfulness of information in digital media
- Philosophical analyses of misinformation phenomena
- Questions on the impact of fake news on society and education
- Critical formation of individuals regarding media and digital technologies
- Reflections on various media and digital formats
- Philosophical foundations of digital literacy and media education
- Critical and competent civic formation in the use of media and digital technologies
- Constructivist and critical approaches to media education
- Philosophical methods for teaching media skills
- Pedagogical strategies for teaching media and digital skills
- Critical thinking for media analysis
- Technical and creative skills for media content production
- Ethics and responsibility in the digital age
- Ethics and responsibility in creating and disseminating digital content
- Impact of media and technology on society
- Education on online privacy and personal data protection
- Strategies for maintaining digital security and ethics in technology use
- Equitable access to technology and media
- Policies and practices to reduce the digital divide and promote technological inclusion
- The role of media literacy in forming informed and participative citizens
- The use of digital media for civic participation
- Ethical dilemmas related to the use of technology and digital media
- Social responsibility and professional ethics in creating and consuming media content
- Integration of media education into the curriculum
- Critical evaluation of educational programs and practices in media literacy
- Emerging trends in digital literacy and their relevance to the future of education
- Globalization through the internet and the power of Artificial Intelligence as a leveling force in education

Article contributions: We welcome articles from prominent representatives in the field of philosophy, addressing the central theme and its implications in psychology, pedagogy, or other disciplines.

Manuscript submission deadline: July 15, 2026
Publication date of this edition: January 15, 2027

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 393-412.

Sophia 43
Philosophy of neuroeducation

lines of research:

- Ethical, epistemological, and methodological implications of applying neuroscientific knowledge in education
- Nature, limitations, and purposes of neuroeducation
- Philosophical reflection on the relationship between neuroscience, psychology, and pedagogy
- Neurobiological foundations of learning
- Brain plasticity and memory consolidation
- Fundamental cognitive processes: attention, perception, memory, and emotions in education
- Principles of neuroscience to improve teaching and learning
- Ethics of neuroeducation
- Informed consent in neuroeducational research
- Critical evaluation of neuroscientific methodologies
- Criticisms of neuroscience and neuroeducation
- Designing learning environments adapted to students' cognitive and emotional needs
- Impact of emotions on learning and memory processes
- Strategies to foster intrinsic motivation and emotional well-being in the classroom
- Lifelong learning and neuroplasticity in adulthood
- Philosophical reflection on the use of emerging technologies like neuroimaging and brain stimulation in educational research
- Philosophical reflection on teacher training and neuroeducation
- Influence of neuroscientific knowledge on educational practice
- Philosophy of mind and neuroeducation
- Moral neuroeducation
- Neuroethics related to education

Article contributions: We welcome articles from prominent representatives in the field of philosophy, addressing the central theme and its implications in psychology, pedagogy, or other disciplines.

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Publication date of this edition: July 15, 2027

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 393-412.

Sophia 44
Ethics of artificial intelligence in education

Lines of research:

- Ethical and moral implications of AI development and use
- Transparency, privacy, and data protection
- Ethical handling of personal data
- Autonomy and educational decision-making with AI systems
- Human autonomy and supervision with AI
- Effects of automation and AI in education
- Philosophical reflection on the use of AI
- Strategies to combat misinformation generated by AI
- Criticisms of machine autonomy and robot ethics
- Cultural and ethical differences in the perception and regulation of AI
- Approaches, perspectives, and trends to address the challenges and opportunities of this technology
- The use of AI in virtual educational environments
- Security, justice, and benefits of AI for stakeholders
- Reflections on equity promoted by AI
- Impact of AI on teachers' responsibilities and students' roles
- Ethics as a balance point between technology and human interaction in the educational process
- Educational assessment
- Ethical use of AI to evaluate student performance
- Ethical approach to the implementation of artificial intelligence in education

Article contributions: We welcome articles from prominent representatives in the field of philosophy, addressing the central theme and its implications in psychology, pedagogy, or other disciplines.

Manuscript submission deadline: July 15, 2027
Publication date of this edition: January 15, 2028

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 393-412.

Sophia 45
Philosophy of education in truth and post-truth

Lines of research:

- Conceptions, theories, and criteria of truth
- Epistemological foundations of how we know the truth
- Theories of knowledge and their application in education
- Implications of truth in educational processes
- The truth in the teacher vs. the truth in the student
- Ethics and truth in educational research
- Types of truth, problems, and limits of truth in education
- Education in truth based on critical thinking
- Education in truth in the post-truth era
- Educational dimension of post-truth
- Intellectual honesty, integrity, objectivity, and rigorous pursuit of knowledge
- Truth as the center of the educational process
- The role of truth in civic education and citizen formation
- Relationship between truth, power, and propaganda in education
- Strategies to promote self-reflection and personal pursuit of truth
- Importance of authenticity and honesty in personal and educational development
- Methods of teaching truth
- Truth in the sciences, humanities, and social sciences
- The pursuit of truth in academic and scientific research
- Cultural relativity and truth
- Teaching truth in a multicultural and pluralistic context

Article contributions: We welcome articles from prominent representatives in the field of philosophy, addressing the central theme and its implications in psychology, pedagogy, or other disciplines.

Manuscript submission deadline: December 15, 2027
Publication date of this edition: July 15, 2028

Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 393-412.

Sophia 46
Philosophy of the environment and education

Lines of research:

- Interaction between environmental philosophy and education
- Philosophical approaches to environmental education
- Environmental ethics in education
- The ethics of respect and care for the environment
- Environmental ethical dilemmas in the classroom
- Transdisciplinary dialogue on sustainable development and regenerative cultures from critical pedagogy
- Philosophy of nature and education, philosophical perspectives on nature influencing education
- The role of education in global sustainability
- Philosophy of ecology in education
- Educational methods to develop ecological awareness
- Environmental education in the formation of ecological values
- Teaching environmental equity
- Ecofeminism in environmental education
- Philosophy of climate change and education
- Climate change from a philosophical perspective
- Critical pedagogy for understanding the environment
- Teaching about the rights of nature
- Philosophical implications of nature
- Philosophical foundations of curriculum integration with environmental topics
- Interdisciplinary curriculum from environmental philosophy
- Anthropocentrism and ecocentrism
- Philosophy and environmental technoscience in education
- Ethics of geoengineering and other technological interventions in the environment
- Ontology of the environment
- Philosophy of ecology
- Criticisms and challenges in implementing the rights of nature

Article contributions: We welcome articles from prominent representatives in the field of philosophy, addressing the central theme and its implications in psychology, pedagogy, or other disciplines.

Manuscript submission deadline: July 15, 2028
Publication date of this edition: January 15, 2029

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 393-412.

Sophia 47
Problems and challenges in the philosophy of education

Lines of research:

- Philosophical foundations of inequality and educational equity in education
- The role of the philosophy of education in cultural diversity
- The role of the philosophy of education in political and civic formation
- Intercultural philosophy and educational competencies in globalization
- Evaluation of the relevance and updating of educational content
- Alternative methods of educational assessment
- Decentralization and governance in education
- Philosophy of education for understanding the mental health of teachers and students
- Pedagogical orientations based on philosophical currents
- Critical thinking in the classroom

Article contributions: We welcome articles from prominent representatives in the field of philosophy, addressing the central theme and its implications in psychology, pedagogy, or other disciplines.

Manuscript submission deadline: December 15, 2028
Publication date of this edition: July 15, 2029

Sophia 48
The role of the teacher in character formation and virtue modeling

Lines of research:

- Character education from philosophy
- Articulation of ethical theory, pedagogical practices, and cultivation of a school environment for moral development
- Philosophical strategies for character education
- Teaching values
- Modeling virtues
- Teachers' behavior and decisions
- Teachers as role models of virtues
- Moral and ethical dilemmas in the classroom
- Philosophy for children programs for developing critical thinking skills
- Experiential learning for character education
- Project-based learning as an experience to strengthen human character
- Importance of interdisciplinarity in character formation
- Influence of the school environment in character formation

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 393-412.

- The practice of virtues as a mechanism for forming the character of the subject
- Character education through developmental stages
- Teaching values
- Philosophical methods, techniques, and strategies for character formation
- Philosophical-pedagogical proposals for character formation
- Personal reflection and self-knowledge as mechanisms for character formation
- Philosophical currents for character formation
- Ethical theories for character formation
- Theories of moral development (Piaget, Kohlberg, etc.)
- Understanding character formation through the relationship between moral and psychological development
- Role of character education in civic participation and the common good
- Role of religion and spirituality in character education
- Importance of religions in character formation
- Criticisms and defenses of character education programs
- Role of mentors in character education
- Character formation from philosophy
- Character formation from pedagogy
- Philosophical and pedagogical strategies for character education
- Interdisciplinary approach to moral education
- Relationship between character and knowledge
- Theories, practices, and school environments in moral development and character education
- Pedagogy and philosophy in moral education
- The art of character formation from pedagogy and moral philosophy
- Philosophy and pedagogical practices for character development

Article contributions: We welcome articles from prominent representatives in the field of philosophy, addressing the central theme and its implications in psychology, pedagogy, or other disciplines.

Manuscript submission deadline: July 15, 2029
Publication date of this edition: January 15, 2030

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 393-412.

Sophia 49
Philosophical foundations and perspectives of transformative education

Lines of research:

- Theoretical foundations of critical consciousness
- Participatory pedagogy as a basis for transformative education
- Contextualized education as key to personal and social transformation
- Interdisciplinarity as a mechanism to address problems
- Critical consciousness as the basis for transformative education
- Participatory pedagogy as a reference for transformative education
- Interdisciplinary approach to education and social transformation
- Foundations of transformative education from Freire to Foucault
- Holistic learning as a foundation for transformative education
- Theory, praxis, and philosophy towards transformative education
- Contextualized education as a basis for personal and social transformation
- Interdisciplinarity and critical consciousness in transformative education
- Philosophical perspectives of transformative education: Freire, Dewey, etc.
- Theories and practices for holistic understanding of transformative education
- Holistic perspective of learning and understanding as a basis for transformative education
- Philosophical foundations of transformative education from Freire, Dewey, Kant, Rousseau, Giroux, Foucault, Gramsci, etc.

Article contributions: We welcome articles from prominent representatives in the field of philosophy, addressing the central theme and its implications in psychology, pedagogy, or other disciplines.

Manuscript submission deadline: December 15, 2029
Publication date of this edition: July 15, 2030

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 393-412.

Sophia 50
Phenomenology of experience in education

Lines of research:

- Study of subjective experience
- Phenomenological methods to understand the mind
- Importance of lived and subjective experiences in integral formation
- Philosophical foundations of lived experience
- Attention and focus as necessary aspects for understanding
- Sensory and cognitive perception in educational experience
- Influence of the temporality of experience on learning
- Impact of time perception on educational experience
- Importance of situational context, physical, educational, social, and cultural space in the learning experience
- Development of personal and professional identity of the main educational agents
- Importance of authenticity in education
- Influence of emotions and feelings on educational experience and learning process
- Relationship between emotion and cognition
- Influence of emotional experiences on understanding and academic performance
- Critical reflection on educational experiences to foster deep and meaningful learning
- Adapting the curriculum to respond to perceptions and needs
- Experiential learning and self-directed discovery
- Reflective and empathetic teaching based on students' perspectives and experiences
- Learning environments to foster interaction and collaboration

Article contributions: We welcome articles from prominent representatives in the field of philosophy, addressing the central theme and its implications in psychology, pedagogy, or other disciplines.

Manuscript submission deadline: July 15, 2030
Publication date of this edition: January 15, 2031

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Convocatorias 2024-2030

Sophia 39
La filosofía en tiempos de la digitalización

Líneas de Investigación: Filosofía de la tecnología educativa; filosofía de la educación en la era digital; filosofía de la inteligencia artificial en la era digital; sentido, significado y finalidad de la inteligencia artificial en la educación; la inteligencia artificial como forma de superación de la inteligencia humana; asistentes virtuales en la educación; corrientes filosóficas que fundamentan a la educación en la era digital; el rol del docente y la automatización de los procesos educativos; reflexiones sobre la educación mediante la metodología virtual; docentes como inmigrantes digitales; identidad híbrida y aplicaciones móviles en el aprendizaje.

Generación de artículos desde representantes de la filosofía destacados en el tema central y sus implicaciones en la filosofía de la educación, en la psicología, en la pedagogía o en otras disciplinas.

Fecha límite para la recepción de manuscritos: 15 de diciembre de 2024
Fecha de publicación de esta edición: 15 de julio de 2025

Sophia 40
La filosofía en la educación de principios y valores

Líneas de Investigación: Filosofía de los valores y su implicación en la educación; el conocimiento de las virtudes morales; didáctica de la ética; didáctica de la axiología; discurso como práctica ética; educación en valores éticos, políticos, cívicos, religiosos; filosofía de la educación basada en la axiología; la libertad, la justicia y la democracia en la educación; lo onto-antropológico en la educación en valores; la importancia de la vocación y la convivencia pacífica en el entorno educativo; corrientes filosóficas que aportan para la educación en valores; la enseñanza de la ética profesional; responsabilidad de los profesionales en la búsqueda y comunicación de la verdad; dilemas éticos relacionados con la verdad en diversas profesiones; dilemas éticos relacionados con el uso de tecnología y medios digitales.

Generación de artículos desde representantes de la filosofía destacados en el tema central y sus implicaciones en la filosofía de la educación, en la psicología, en la pedagogía o en otras disciplinas.

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Sophia 38: 2025.

Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 393-412.

Sophia 41
Categorías fundamentales para la comprensión de la filosofía de la educación en la sociedad actual

Líneas de Investigación: Teoría educativa; categorías ónticas y ontológicas de la filosofía de la educación; teoría crítica de la educación; paradojas del pensamiento crítico y realidad educativa; naturaleza y filosofía del aprendizaje, perspectiva crítica de la metodología y la innovación educativa; pedagogías y metodologías críticas; autoconcepto y estrategias metacognitivas; contribuciones de la lógica formal, de la lógica modal, de la lógica dialéctica para la comprensión de la filosofía de la educación

Generación de artículos desde representantes de la filosofía destacados en el tema central y sus implicaciones en la psicología, en la pedagogía o en otras disciplinas.

Fecha límite para la recepción de manuscritos: 15 de diciembre de 2025
Fecha de publicación de esta edición: 15 de julio de 2026

Sophia 42
Filosofía en la comunicación mediática los medios digitales en la educación

Líneas de Investigación: Reflexiones sobre la educación mediática; la veracidad de la información en medios digitales; análisis filosóficos de los fenómenos de desinformación; cuestionamientos sobre el impacto de las noticias falsas (fake news) en la sociedad y la educación; la formación crítica de los individuos en relación con los medios de comunicación y las tecnologías digitales; reflexiones sobre diversos formatos mediáticos y digitales; fundamentos filosóficos de la alfabetización digital y la educación mediática; formación ciudadana crítica y competente en el uso de medios y tecnologías digitales; enfoques constructivistas y críticos en la educación mediática; métodos filosóficos para la enseñanza de habilidades mediáticas; estrategias pedagógicas para la enseñanza de habilidades mediáticas y digitales; pensamiento crítico para el análisis de medios; habilidades técnicas y creativas para la producción de contenido mediático; ética y responsabilidad en la era digital; ética y responsabilidad en la creación y difusión de contenido digital; impacto de los medios y la tecnología en la sociedad; educación sobre la privacidad en línea y protección de datos personales; estrategias para mantener la seguridad digital y la ética en el uso de tecnologías; acceso equitativo a la tecnología y a los medios de comunicación; políticas y prácticas para reducir la brecha digital y promover la inclusión tecnológica; rol de la alfabetización mediática en la formación de ciudadanos informados y participativos; el uso de los medios digitales para la participación cívica; dilemas éticos relacionados con el uso de tecnología y medios digitales; responsabilidad social y ética profesional en la creación y consumo de conteni-

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do mediático; integración de la educación mediática en el currículo; evaluación crítica de programas y prácticas educativas en alfabetización mediática; tendencias emergentes en la alfabetización digital y su relevancia para el futuro de la educación; La globalización mediante internet y el poder de la Inteligencia Artificial como fuerza de nivelación de la educación

Generación de artículos desde representantes de la filosofía destacados en el tema central y sus implicaciones en la psicología, en la pedagogía o en otras disciplinas.

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Sophia 43
Filosofía de la neuroeducación

Líneas de Investigación: Implicaciones éticas, epistemológicas y metodológicas de aplicar conocimientos neurocientíficos en la educación; naturaleza, limitaciones y finalidades de la neuroeducación; reflexión filosófica de la relación entre neurociencia, psicología y pedagogía; bases neurobiológicas del aprendizaje; plasticidad cerebral y consolidación de la memoria; procesos cognitivos fundamentales: atención, percepción, memoria y emociones en la educación; principios de la neurociencia para mejorar la enseñanza y el aprendizaje; ética de la neuroeducación; el consentimiento informado en la investigación neuroeducativa; evaluación crítica de las metodologías neurocientíficas; críticas a la neurociencia y a la neuroeducación; diseño de entornos de aprendizaje adaptados a las necesidades cognitivas y emocionales de los estudiantes; impacto de las emociones en los procesos de aprendizaje y memoria; estrategias para fomentar la motivación intrínseca y el bienestar emocional en el aula; aprendizaje a lo largo de la vida y neuroplasticidad en la edad adulta; reflexión filosófica sobre el uso de tecnologías emergentes como la neuroimagen y la estimulación cerebral en la investigación educativa; reflexión filosófica sobre la formación docente y la neuroeducación; influencia de los conocimientos neurocientíficos en la práctica educativa; filosofía de la mente y neuroeducación; neuroeducación moral; neuroética vinculada con la educación.

Generación de artículos desde representantes de la filosofía destacados en el tema central y sus implicaciones en la psicología, en la pedagogía o en otras disciplinas.

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Sophia 44
Ética de la inteligencia artificial en la educación

Líneas de Investigación: Implicaciones éticas y morales del desarrollo y uso de la IA; transparencia, privacidad y protección de datos; manejo ético de los datos personales; autonomía y toma de decisiones educativas con los sistemas de IA; autonomía y supervisión humana con la IA; efectos de la automatización y la IA en la educación; reflexión filosófica sobre el uso de la IA; estrategias para combatir la desinformación generada por la IA; críticas sobre la autonomía de las máquinas y la ética de los robots; diferencias culturales y éticas en la percepción y regulación de la IA; enfoques, perspectivas y tendencias para abordar los desafíos y oportunidades que presenta esta tecnología; el uso de la IA en entornos virtuales educativos; seguridad, justicia y beneficios de la IA para los involucrados; reflexiones sobre la equidad promovida desde la IA; impacto de la IA en las responsabilidades del docente y en el rol del estudiante; la ética como punto de equilibrio entre tecnología e interacción humana en el proceso educativo; la evaluación educativa; uso ético de la IA para evaluar el rendimiento estudiantil; enfoque ético en la implementación de la inteligencia artificial en la educación.

Generación de artículos desde representantes de la filosofía destacados en el tema central y sus implicaciones en la psicología, en la pedagogía o en otras disciplinas.

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Sophia 45
Filosofía de la educación en la verdad y la post-verdad

Líneas de Investigación: Concepciones, teorías y criterios de verdad; fundamentos epistemológicos de cómo conocemos la verdad; teorías del conocimiento y su aplicación en la educación; implicaciones de la verdad en los procesos educativos; la verdad en el docente vs la verdad en el estudiante; ética y verdad en la investigación educativa; clases de verdad, problemas y límites de la verdad en la educación; educación en la verdad basada en el pensamiento crítico; educación en la verdad en la era de la posverdad; dimensión educativa de la posverdad; honestidad intelectual, integridad, objetividad y búsqueda rigurosa del conocimiento; la verdad como centro del proceso educativo; el rol de la verdad en la educación cívica y en la formación de ciudadanos; relación entre verdad, poder y propaganda en la educación; estrategias para fomentar la auto-reflexión y la búsqueda personal de la verdad; la importancia de la autenticidad y la honestidad en el desarrollo personal y educativo; métodos de enseñanza de la verdad; la verdad en las ciencias, las humanidades y las ciencias sociales; la búsqueda de la verdad en la investigación académica y científica;

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relatividad cultural y verdad; enseñanza de la verdad en un contexto multicultural y pluralista.

Generación de artículos desde representantes de la filosofía destacados en el tema central y sus implicaciones en la psicología, en la pedagogía o en otras disciplinas.

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Sophia 46
Filosofia del medio ambiente y educación

Líneas de Investigación: Interacción entre filosofía del medio ambiente y la educación; enfoques filosóficos en la educación ambiental; ética ambiental en la educación; la ética de respeto y cuidado por el medio ambiente; dilemas éticos ambientales en el aula; diálogo transdisciplinar sobre el desarrollo sostenible y culturas regenerativas desde la pedagogía crítica; filosofía de la naturaleza y educación, perspectivas filosóficas sobre la naturaleza que influyen en la educación; el papel de la educación en la sostenibilidad global; filosofía de la ecología en la educación; métodos educativos para desarrollar una conciencia ecológica; la educación ambiental en la formación de valores ecológicos; enseñanza de la equidad ambiental; ecofeminismo en la educación ambiental; filosofía del cambio climático y educación; cambio climático desde una perspectiva filosófica; pedagogía crítica para la comprensión del medio ambiente; enseñanza sobre los derEcos de la naturaleza; implicaciones filosóficas sobre la naturaleza; fundamentos filosóficos de la integración curricular con temas ambientales; currículo interdisciplinario desde la filosofía ambiental; antropocentrismo y ecocentrismo; filosofía y tecnociencia ambiental en la educación; ética de la geoingeniería y otras intervenciones tecnológicas en el medio ambiente; ontología del medio ambiente; filosofía de la ecología; críticas y desafíos en la implementación de los derEcos de la naturaleza.

Generación de artículos desde representantes de la filosofía destacados en el tema central y sus implicaciones en la psicología, en la pedagogía o en otras disciplinas.

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Sophia 47
Problemas y desafíos de la filosofía de la educación

Líneas de Investigación: Fundamentos filosóficos de la desigualdad y la equidad educativa en la educación; papel de la filosofía de la educación en la diversidad cultural; función de la filosofía de la educación en la formación política y ciudadana; filosofía intercultural y competencias educativas en la globalización; evaluación de la relevancia y actualización del contenido educativo; métodos alternativos de evaluación educativa; descentralización y gobernanza en la educación; la filosofía de la educación para la comprensión de la salud mental de docentes y estudiantes; orientaciones pedagógicas basadas en corrientes filosóficas; el pensamiento crítico en el aula.

Generación de artículos desde representantes de la filosofía destacados en el tema central y sus implicaciones en la psicología, en la pedagogía o en otras disciplinas.

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Sophia 48
La función del docente en la formación del carácter y en la modelación de virtudes

Líneas de Investigación: La educación del carácter desde la filosofía; articulación de teoría ética, prácticas pedagógicas y cultivo de un ambiente escolar para el desarrollo moral; estrategias filosóficas para la educación del carácter; enseñanza de valores; modelado de virtudes; comportamiento y decisiones de los docentes; docentes como modelos de las virtudes; dilemas morales y éticos en el aula; programas de filosofía para niños para el desarrollo de habilidades de pensamiento crítico; el aprendizaje experiencial para la educación del carácter; el aprendizaje basado en proyectos como experiencia para fortalecer el carácter del ser humano; importancia de la interdisciplinariedad en la formación del carácter; influencia del ambiente escolar en la formación del carácter; la práctica de las virtudes como mecanismo para la formación del carácter del sujeto; la educación del carácter a través del desarrollo evolutivo; la enseñanza de valores; métodos filosóficos, técnicas y estrategias para formar el carácter; propuestas filosófico-pedagógicas para la formación del carácter; la reflexión personal y el autoconocimiento como mecanismos para la formación del carácter; corrientes filosóficas para la formación del carácter; teorías éticas para la formación del carácter; teorías del desarrollo moral (Piaget, Kohlberg, etc.); comprensión de la formación del carácter desde la relación entre desarrollo moral y desarrollo psicológico; función de la educación del carácter en la participación ciudadana y el bien común; rol de la religión y la espiritualidad en la educación del carácter; importancia de las religiones en la formación del carácter; críticas y defensas de los programas de educación del carácter; rol de los mentores en la educación

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del carácter; la formación del carácter desde la filosofía; formación del carácter desde la pedagogía; estrategias filosóficas y pedagógicas para la educación del carácter; enfoque interdisciplinario en la educación moral; relación carácter y conocimiento; teorías, prácticas y ambientes escolares en el desarrollo moral y la educación del carácter; pedagogía y filosofía en la educación moral; el arte de formar el carácter desde la pedagogía y la filosofía moral; filosofía y prácticas pedagógicas para el desarrollo del carácter

Generación de artículos desde representantes de la filosofía destacados en el tema central y sus implicaciones en la psicología, en la pedagogía o en otras disciplinas.

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Sophia 49
Fundamentos y perspectivas filosóficas de la educación transformadora

Líneas de Investigación: Fundamentos teóricos sobre la conciencia crítica; la pedagogía participativa como base para la educación transformadora; educación contextualizada clave para la transformación personal y social; la interdisciplinariedad como mecanismo para abordar problemas; conciencia crítica como base para la educación transformadora; la pedagogía participativa como referente para una educación transformadora; enfoque interdisciplinario para la educación y transformación social; fundamentos de la educación transformadora de Freire a Foucault; aprendizaje holístico como fundamento para la educación transformadora; teoría, praxis y filosofía en clave hacia una educación transformadora; la educación contextualizada como base para la transformación personal y social; interdisciplinariedad y conciencia crítica en la educación transformadora; perspectivas filosóficas de la educación transformadora: Freire, Dewey, etc.; teorías y prácticas para la comprensión holística de la educación transformadora; perspectiva holística del aprendizaje y la comprensión como base para la educación transformadora; fundamentos filosóficos de la educación transformadora desde Freire, Dewey, Kant, Rousseau, Giroux, Foucault, Gramsci; etc.

Generación de artículos desde representantes de la filosofía destacados en el tema central y sus implicaciones en la psicología, en la pedagogía o en otras disciplinas.

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Sophia 50
Fenomenología de la experiencia en la educación

Líneas de Investigación: Estudio de la experiencia subjetiva; métodos fenomenológicos para comprender la mente; importancia de las experiencias vividas y subjetivas en la formación integral; fundamentos filosóficos de la experiencia vivida; atención y focalización como aspectos necesarios para la comprensión; la percepción sensorial y cognitiva en la experiencia educativa; influencia de la temporalidad de la experiencia en el aprendizaje; incidencia de la percepción del tiempo en la experiencia educativa; importancia del contexto situacional, del espacio físico educativo, social y cultural en la experiencia del aprendizaje; desarrollo de la identidad personal y profesional de los principales agentes de la educación; importancia de la autenticidad en la educación; influencia de las emociones y los sentimientos en la experiencia educativa y en el proceso de aprendizaje; relación entre emoción y cognición; influencia de las experiencias emocionales en la comprensión y rendimiento académico; reflexión crítica sobre las experiencias educativas para fomentar el aprendizaje profundo y significativo; adaptación del currículo para responder a las percepciones y necesidades. aprendizaje experiencial y el descubrimiento autodirigido; enseñanza reflexiva y empática basada en las perspectivas y vivencias de los estudiantes; ambientes de aprendizaje para fomentar la interacción y la colaboración.

Generación de artículos desde representantes de la filosofía destacados en el tema central y sus implicaciones en la psicología, en la pedagogía o en otras disciplinas.

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