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INTRODUCTION TO THE SPECIAL ISSUE / INTRODUCCIÓN AL MONOGRÁFICO /

Open Education and Open Science: New Perspectives for Innovation and Collaboration Ciencia Abierta y Educación Abierta: Nuevas perspectivas para la innovación y la colaboración

Adriana Gewerc Barujel¹ & Rocío Anguita Martínez² (*Guests editors*)

Abstract: In the current ecosocial and political context—marked by profound transformations in ways of living, learning, and conducting research—this RELATEC monographic issue emerges as a plural space for pedagogical and epistemological reflection. It brings together eight contributions focused on education as a domain of social transformation, integrating approaches such as open science, participatory methodologies, collaborative networks, and emerging technologies. These contributions originate from the First Ibero-American Meeting on Open Science and Open Education (Montevideo, 2024), organized by the DAI and REUNI+D networks, as part of the LACLO 2024 event. The articles explore experiences and research aimed at fostering a critical and engaged global citizenship. They address institutional challenges to implementing open science in Europe and Spain, emphasizing the need for regulatory coherence, inter-institutional collaboration, and specific training. The JIRG model is introduced, positioning youth as researchers of global challenges, along with Global Quest, a co-designed educational game that encourages youth engagement in sustainability, diversity, and rights. Other contributions include a citizen science initiative on biodiversity in Brazil, an analysis of collaborative networks between universities and schools, the application of generative artificial intelligence in research training, and a critical review of the eduCAPES open educational resources portal. The issue concludes with an examination of data repository quality in educational research based on the FAIR and TRUST principles. Altogether, this monographic issue proposes a reconfiguration of the relationship between science, education, and society, promoting open, inclusive, and socially engaged practices that support meaningful knowledge creation and transformative action

Keywords: Open Science, Research Networks, Universities, Institutional Cooperation.

Resumen: En el contexto ecosocial y político actual, caracterizado por profundas transformaciones en los modos de habitar, aprender e investigar, este monográfico de RELATEC se presenta como un espacio plural de reflexión pedagógica y epistemológica. Reúne ocho contribuciones centradas en la educación como ámbito de transformación social, con enfoques que integran ciencia abierta, metodologías participativas, redes colaborativas y tecnologías emergentes. Estas propuestas surgen del Primer Encuentro Iberoamericano de Ciencia Abierta y Educación Abierta (Montevideo, 2024), organizado por las redes DAI y REUNI+D, en el marco del evento LACLO 2024. Los artículos abordan experiencias e investigaciones orientadas a fortalecer una ciudadanía global crítica y comprometida. Se analizan los desafíos institucionales de la ciencia abierta en Europa y España, destacando la necesidad de coherencia normativa, colaboración interinstitucional y formación específica. Se presenta el modelo JIRG, que sitúa a jóvenes como investigadores de retos globales, y experiencias como Global Quest, un juego educativo diseñado colectivamente para fomentar la participación juvenil en temas de sostenibilidad y derechos. Otras aportaciones incluyen una iniciativa de ciencia ciudadana sobre biodiversidad en Brasil, el análisis de redes colaborativas entre universidad y escuela, el uso de inteligencia artificial generativa en la formación investigadora, y una mirada crítica al portal de REA eduCAPES. Finalmente, se examina la disponibilidad y calidad de los repositorios de datos educativos según los principios FAIR y TRUST. En su conjunto, este monográfico propone una reconfiguración del vínculo entre ciencia, educación y sociedad, promoviendo prácticas abiertas, inclusivas y comprometidas con la transformación social y el conocimiento significativo.

Palabras clave: Ciencia Abierta, Redes de investigación, Universidades, Cooperación institucional.

Within the contemporary ecosocial and political context that deeply questions how we inhabit, learn, and conduct research, this special issue is conceived as a plural space for pedagogical and epistemological reflection. It brings together eight contributions focused on education as a domain of social transformation, putting into dialogue approaches from Open Science, participatory methodologies, collaborative networks, and emerging technologies, all oriented toward strengthening a critical, engaged global citizenship.

The body of work assembled here has its genesis in the Primer Encuentro Iberoamericano de Ciencia Abierta y Educación Abierta (First Ibero-American Meeting on Open Science and Open Education), held in October 2024 in Montevideo (Uruguay) as a satellite event of LACLO 2024. The meeting was jointly organized by DAI, the «Red de Datos Abiertos de Investigación» and REUNI+D, the «Red Universitaria de Investigación e Innovación Educativa. Conectando Redes y Promoviendo el Conocimiento Abierto» (Spanish Ministry of Science, Innovation and Universities; State Research Agency, RED2022-134187-T).

The contributions presented here share a concern for generating knowledge in open, inclusive, and meaningful ways, recognizing the participation of subjects—especially young people and educational communities—in its construction. From diverse geographic and disciplinary contexts, the authors explore methodological tools, institutional dilemmas, and concrete experiences that aim to reconfigure the relationship among science, education, and society.

The article by Gewerc and Anguita situates the debate at the institutional and political level by analyzing the implementation of Open Science in Europe and Spain, with particular attention to the activities of the REUNI+D network. Using a mixed-methods design, the study explores perceptions, knowledge, and obstacles faced by educational research groups as they move toward more transparent, collaborative, and accessible models of scientific production. The authors call attention to regulatory fragmentation that hinders the coherent development of Open Science policies, and propose an articulation based on the «three Cs»: Coherence, Collaboration, and Coordination. The work highlights the need for targeted training for the research community and makes visible the tensions among technical, cultural, and institutional dimensions that demand an integrated approach.

The contribution from Calvo, DePalma, Rodríguez-Hoyos, and Hevia reinforces the central role of young people in processes of educational transformation by presenting the JIRG methodological process (Personas Jóvenes como Investigadoras de Retos Globales—Young People as Researchers of Global Challenges) as a way to foster youth engagement in global citizenship. Structured in ten stages inspired by the «students as researchers» movement, the model enables young people to identify concerns, formulate questions, and propose concrete solutions to challenges that affect them. Its commitment to dialogic, horizontal methodologies foregrounds youth voice as a legitimate source of knowledge, challenging traditional models of teaching and research. The approach promotes connections between the local and the global and reasserts the transformative role of open educational practices.

The collaborative work by Braga, Fueyo-Gutiérrez, Fano-Méndez, and Valdez-Argüelles opens the collection with a powerful ludopedagogical proposal: «Global Quest», a collaborative game co-designed within the frameworks of citizen science and

education for global citizenship. Implemented with more than 400 adolescent participants and socioeducational professionals, the game demonstrates its capacity to elicit young people's perspectives on issues such as diversity, sustainability, and rights, while also generating dynamics of critical reflection and inclusion. Beyond its didactic function, the game is conceived as a research tool—an exemplary case of the creative potential of co-investigation in educational settings. Methodological and epistemic openness here is the condition of possibility for imagining new forms of youth participation.

The contribution by Lima and Catafesta extends this perspective through a concrete experience of citizen science and environmental education on the campus of the Universidade Federal de Santa Catarina (UFSC). By co-creating a campus bird field guide in collaboration with both academic and external community members, the project mobilized practices such as field outings, curation of photographic records, and the development of descriptive content. Use of the iNaturalist platform broadened the project's reach and connected local knowledge with global Open Science infrastructures. Beyond outcomes related to biodiversity and conservation, the experience underscored the transformative power of citizen participation in strengthening the bond between science and territory.

The study by Ocaña, Leite, Del Río, and Martagón focuses on analyzing collaborative networks between universities and schools across diverse contexts: learning communities, pedagogical laboratories, and rural settings. Through a multicase study, the authors illustrate ways of generating pedagogical knowledge from critical, democratic, and transdisciplinary perspectives. These networks not only enable the design and implementation of innovative educational practices, but also support the transfer of learning beyond academic spheres, directly impacting institutional improvement processes. The work brings to the fore the value of relationships, dialogue, and inclusion as foundations of an educational research agenda committed to social transformation.

The article by Antúnez dos Santos and Berni Reategui brings emerging technologies into the arena of research training by exploring the combined use of word co-occurrence analysis and Generative Artificial Intelligence (IAGen) to support scoping design in higher education projects. Based on personalized reports, the intervention enabled university students to reflect on keyword definition, refine their literature searches, and strengthen their research autonomy. The findings suggest that such tools can enrich metacognitive processes and facilitate the conceptual structuring of early-stage projects—especially when coupled with appropriate pedagogical mediation.

From Brazil, the article by Damiaty and Amiel offers a critical analysis of the «eduCAPES» portal, the principal instrument for promoting Open Educational Resources (OER) within the Universidade Aberta do Brasil (UAB). Through a multidimensional lens—documentary, technical, and conceptual—the authors identify obstacles to the portal's consolidation, including lack of institutional identity, tensions among stakeholders, and weak strategic alignment. The study concludes that OER cannot be reduced to technical questions of functionality; rather, they must be anchored in a political project that recognizes openness as an organizing principle. Integrating repositories into public educational policies requires a structural perspective that combines participatory governance, conceptual coherence, and sustained institutional commitment.

The closing article, by Torterolo and Motz, offers a critical look at data repositories in educational and social science research, analyzing their alignment with the FAIR and TRUST principles. Drawing on methodological triangulation (literature review, expert interviews, and catalog analysis), the study identifies a troubling scarcity of specialized repositories in these disciplines compared with other areas of knowledge. The authors underscore the importance of criteria such as reputation, ease of use, sustainability, technical support, and the availability of contextual information, along with proper ethical protection for sensitive data. The study argues that repositories have ceased to be mere deposit sites; they have become strategic infrastructures for Open Science whose quality must be assessed through robust technical, legal, and epistemic frameworks.

Taken together, the articles in this special issue constitute a plural cartography of emerging practices that seek to transform how we conduct research and educate in contemporary times. Through innovative methodological proposals, institutional analyses, participatory experiences, and technological developments, they articulate a horizon in which openness, collaboration, and inclusion are not merely normative principles but ethical-political foundations of an active global citizenship.

Far from limiting itself to a technical review of tools or policies, this collection invites us to think of education and research as territories of dispute, imagination, and collective creation. Across local, national, and transnational scales, it reaffirms the possibilities of generating meaningful knowledge in dialogue with communities, contexts, and real-world challenges. This special issue, therefore, does more than document progress—it issues a call: an invitation to transform.



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ARTICLE / ARTÍCULO

Implications, contradictions and possibilities of open science in Spain: The REUNI+D case

Implicaciones, contradicciones y posibilidades de la ciencia abierta en España: El caso REUNI+D

Adriana Gewerc Barujel¹ & Rocío Anguita Martínez²

Abstract: This article reviews the status of open science as a paradigm of scientific practice that is currently being implemented. It addresses the policies developed by the European Union and their specific implementation in Spain, as well as the discrepancies and barriers that their implementation is encountering in the Spanish university system. It then examines the REUNI+D network in more detail, describing the activities and proposals carried out by its 14 educational research groups from 13 Spanish universities between 2019 and the present day. A mixed research methodology is employed, incorporating a questionnaire as a tool to identify the knowledge and perceptions of network members on science and open education, as well as the obstacles encountered. The findings indicate that members possess precise understanding of the concept of open science and its potential to foster collaboration, accessibility, and comprehension of the entire research life cycle. This underscores the necessity for training processes to be developed within the new framework. The final discussion highlights the difficulty for each higher education institution to generate different policies and regulations in this regard, leading to contradictions in evaluation and the need for the three Cs (Coherence, Collaboration and Coordination) for the development of open science.

Keywords: Open Science, Research Networks, Universities, Institutional Cooperation.

Resumen: En este artículo se repasa la situación de la ciencia abierta como paradigma de la práctica científica que se encuentra en pleno proceso de implantación, abordando las políticas desarrolladas por la Unión Europea y su desarrollo concreto en España, así como las discrepancias y barreras que está suponiendo su implantación en el sistema universitario español. A partir de aquí se estudia el caso concreto de la Red REUNI+D, que abarca 14 grupos de investigación educativa de 13 universidades españolas desde el año 2019 hasta la actualidad donde se describen las actividades y propuestas realizadas en su marco. Se utiliza una metodología de investigación mixta con el uso de un cuestionario como instrumento para identificar el conocimiento y las percepciones de los miembros de la red sobre ciencia y la educación abierta, así como los obstáculos. En los resultados se constata que los miembros tienen un conocimiento certero sobre qué es la ciencia abierta y las posibilidades que abre a la colaboración, la accesibilidad y a conocer todo el ciclo de vida de las investigaciones, resaltando la necesidad de procesos formativos sobre el nuevo marco generado. En la discusión final se pone de relieve la dificultad de que cada institución de educación superior genere una política y normativas diferentes al respecto, generando contradicciones en la evaluación y la necesidad del trabajo de las tres C (Coherencia, Colaboración y Coordinación) para el desarrollo de la ciencia abierta.

Palabras clave: Ciencia Abierta, Redes de investigación, Universidades, Cooperación institucional.

1. Introduction

Open Science is defined as

«an inclusive construct that combines various movements and practices aiming to make multilingual scientific knowledge openly available, accessible and reusable for everyone, to increase scientific collaborations and sharing of information for the benefits of science and society, and to open the processes of scientific knowledge creation, evaluation and communication to societal actors beyond the traditional scientific community» (da Silveira et al., 2023, p.3).

It is implied that advances are available to all, especially when they have been developed with public funding from states, and that publications, data, practices, methodologies and processes derived from research are accessible to the scientific community and the public. Furthermore, it places emphasis on the involvement of citizens, emphasising the commitment to fostering socially responsible research environments and initiatives. The objective is to disseminate the processes and outcomes of research to both the scientific community and the society that funds it. This approach is instrumental in facilitating the replication of research findings and promoting the dissemination of their social value.

1.1. Open science in Europe and Spain

At least ten of the seventeen Sustainable Development Goals (SDGs) that make up the 2030 Agenda for Sustainable Development require ongoing scientific input. Given that these goals must be achieved globally, it is absolutely necessary to remove restrictions on the dissemination of research results to the intended stakeholders, regardless of their geographical location and the financial situation of the institutions and individuals seeking information (UNESCO, 2014). On 27 May 2016, all Member States of the European Union committed to making publicly funded scientific results available online, at no additional cost to other researchers in the research community, as well as to policy-makers, businesses and the general public. However, as reported by the EU Commissioner for Research, Science and Innovation in September 2018, 'despite this commitment, a large number of scientific articles continue to be published in journals that are only accessible to those who can and are willing to pay subscription fees'. Several obstacles still need to be addressed.

UNESCO (2021) argues that scientific knowledge is a common good and should be shared. This principle has been adopted by the European Union, which has been developing an open access strategy since 2018, requiring that the results of the research it funds be published in universally accessible and free journals and platforms. In line with other institutions (UNESCO, UN, etc.), it aims to address the challenges of an increasingly digitalised society from the perspective of promoting sustainability and building a global, open, stable and secure cyberspace. In its declaration on Open Educational Resources (OER), UNESCO (2024) affirms the transformative potential of Open Education (OE) and Open Science (OS) as a cornerstone for equitable and inclusive access to knowledge in the digital age.

Since 2020, scientists and researchers who receive research funding from EU state agencies and institutions have been required to publish their work in open

repositories or in accessible journals (see the 7th Framework Programme (FP7), Horizon 2020 and Horizon Europe).

That said, we can conclude that the incorporation of OS in different EU countries has progressed, but there are still challenges that have yet to be addressed and tasks that remain to be accomplished in order to put theory into practice. It is essential to develop a regional regulatory framework that enables collaborative work and growth among institutions in the same geographical region. Specifically, teaching and research staff must be trained; policies recognising open science activities must be adopted; university governing bodies with competences in this area must be involved; and practices for disseminating institutional strategies must be developed. Addressing these issues is fundamental to consolidating Open Science and achieving significant cultural change within institutions.

Spain is committed to open science through the Science, Technology and Innovation Act and the Organic Law on the University System (LOSU). Within this framework, it is mandatory to deposit a copy in this type of digital repository, without prejudice to its availability elsewhere. Progress has already been made in evaluating researchers' scientific output over six-year periods and in the rules imposed by the Spanish Research Agency on the financing of research projects. To implement these initiatives, repositories have been created in universities and research centres. Nevertheless, research results continue to be evaluated based on publication in top-ranked international journals, which are generally owned by private corporations that charge high fees for open access.

Efforts have been made in this regard in Spain. In 2007, RECOLECTA, the national aggregator of open access repositories, was launched. This platform brings together all Spanish digital infrastructures where research results are published and/or deposited in open access. In 2009, OpenAIRE¹ was created, funded by the Seventh Framework Programme. It is a service platform to support, accelerate and measure the proper implementation of European open access policies for scientific publications and research data. OpenAIRE has a large network of agents who act as national reference points to disseminate and promote the European Commission's open access policies among institutions and researchers, as well as to facilitate the coordination of national policies with European ones. In June 2018, FECYT launched the pilot project 'Infrastructures and Standards for Open Science' (INEOS)² in collaboration with three public research bodies: the Spanish National Research Council (CSIC)³, the Carlos III Health Institute (ISCIII)⁴ and the National Institute for Agricultural and Food Research and Technology (INIA)⁵. The objective was to link the results of publicly funded research with the data used in the research, with the aim of improving the quality of data in repositories and increasing researchers' visibility by creating public CV profiles in various institutional spaces.

On 19 February 2019, the General Assembly of the CRUE approved the «Commitments of Universities to Open Science» document⁶. In line with this, Spanish

¹ <https://www.openaire.eu>

² <https://bit.ly/ineosfecyt>

³ <https://www.csic.es/es/el-csic>

⁴ <https://www.isciii.es/inicio>

⁵ <https://www.inia.es/>

⁶ <https://bit.ly/cruccienciaabierta>

universities have clearly committed to the so-called 'green route' over the last decade by developing institutional repositories and approving policies that require, encourage or recommend the self-archiving of publications. Consequently, 105 repositories have been established in research centres and universities based on these institutional policies. Additionally, in line with the European Union's approach, Article 37 of the Science, Technology and Innovation Act stipulates that any publication resulting from a project financed mainly from the Spanish state budget must be deposited in an open access repository. However, the percentage of content hosted in open repositories does not yet reach the desired level for 2020, with some exceptions. Measurement of Open Access in Spanish universities and the CSIC for the period 2019–2023 (CRUE, 2025) shows a significant increase in the percentage of open-access articles: from 75.6% (77,731 publications) in 2022 to 80% (82,413 publications) in 2023. These figures vary depending on the centre. Despite all these efforts, Europe and Latin America have not yet been able to adopt Open Science initiatives on a widespread basis.

1.2. Open Science, universities and platform capitalism

The paradigm shift initiated by open science and education must be accompanied by a comprehensive review of university policies, encompassing essential modifications to incentive policies and project evaluation, as well as the working culture of the various stakeholders within R&D systems. Consequently, universities are confronted with considerable challenges and are compelled to address the contradictions that may emerge.

Research in this area has highlighted discrepancies between the concept of open science and academic reality, identifying two main barriers: individual and systemic (Scheliga & Friesike, 2014). In essence, a number of authors have arrived at the conclusion that, upon rigorous examination of the deficiencies inherent in contemporary science that the open science movement is designed to address, the prospects for enhancement appear to be negligible (Mirowski 2018). In this context, collaborative practices and research networks are considered essential elements for innovation and open science (Ramírez-Montoya and García-Peñalvo 2018).

A salient contradiction in the extant literature pertains to the vicious circle that involves researchers being evaluated for publishing in journals that appear in the top quartiles and belong to private business conglomerates. This implies an implicit contract whereby research funding is paid for twice: once by the state and again through subscriptions to access the documents (D'Antonio Maceiras, 2018; Goyanes & Rodríguez-Gómez, 2018; Córdoba-González, 2019). A strong movement has emerged in response to this phenomenon, with some results, but so far, far from being a moral force to counteract the greed of corporate publishers, the reaction has generated new strategies to increase revenue, such as charging publication fees for open access, an issue that has been exacerbated by the mandatory nature of open access for research evaluation since the implementation of the LOSU.

Embracing open science by institutions poses the challenge of making the results, processes and data on which it is based available to the community. However, openness and transparency can benefit the private expropriation of results by monetising open resources. Hence the intermittent flirtation of pharmaceutical companies with open science (Mirowski, 2018), an obvious risk that is important to analyse. Within the framework of current neoliberal policies, which have sought to

weaken universities and the research carried out therein over the last twenty years (De Souza Santos, 2006; AUTHOR, 2014; Diez-Gutiérrez, 2019), we must be vigilant to ensure that the open science proposal does not become another twist of the same policies.

The transparency, authenticity and timeliness offered by open science could reveal the scientific process in real time, allowing claims to be viewed in the context of their underlying data. Open science therefore has the potential to contribute to substantiating relationships that are fundamental to both people's trust in science and science's trust in people (Grand et al., 2012). It is therefore important to carefully analyse the implications that platform capitalism may have for this development. This is no trivial matter, as platform capitalism can appropriate the discourse of open science to pave the way for its ultimate monetisation. The technology platform landscape for science (e.g. Academia.edu, Researchgate and Mendeley) reveals a clear business model that must be dismantled, as at each stage of research it provides external third parties with the capabilities to evaluate, validate, brand and monitor research programmes (Srnicek, 2018). Their nominal 'openness' provides the ideal configuration for near real-time surveillance of the research process — a panopticon of science — which can be exploited and sold in the same way that Facebook or Instagram exploit and sell real-time surveillance of consumer behaviour.

Finally, both science and open education present the challenge of dissemination, seeking to bring science closer to society. This is why citizen science has become one of the eight key priorities of the European Open Science Agenda (2018), alongside the establishment of the European Open Science Cloud (EOSC) (2021). The EOSC facilitates collaboration between multidisciplinary research infrastructures (Otsu and Masó, 2023). The idea is to involve the entire population in a concept of science that provides answers to real problems and needs, and ensures that the results of science are not left in the hands of a few. Therefore, the important question is not who does science, but who it serves. Within this framework, citizen and social innovation laboratories, or medialabs, are gaining momentum as spaces where open science is constructed and disseminated. These labs promote the social construction of knowledge, particularly the generation of new frameworks for understanding and action by epistemic cultures that favour the social and open construction of knowledge (Bradley, 2006). These medialabs open up new avenues for collective work, promoting forms of exchange and relationships that transcend traditional disciplines. This allows for the creation of environments based on the integration of knowledge fields and the formation of diverse communities of practice and emerging pedagogical initiatives. These citizen science practices are linked to educational and training activities, as well as participatory research, and enable the dissemination and transfer of educational research.

1.3. The REUNI+D network. Open science and education: development and activities

Since its inception, the REUNI+D network was created to become a (virtual) space for resources and knowledge to support and promote the work of researchers in the field of educational innovation. It has a track record of more than ten years of uninterrupted work and, in the process, has helped to strengthen the participating groups by demonstrating the value of collaboration for scientific development (Sancho Gil, et. al. 2022). It currently consists of 14 established research groups: ESBINA (University of

Barcelona); PROCIE (University of Malaga); ICUFOP (University of Granada); ELKARRIKERTUZ (University of the Basque Country); EDULLAB (University of La Laguna); EDUDIG and INFORAL (University of Salamanca); STELLAE (University of Santiago de Compostela); GIETE (University of Seville); INDUCT (Complutense University of Madrid); NODO EDUCATIVO (University of Extremadura); CEAEX (University of Valladolid); GLOBAL EDUCATION (University of Cantabria) and IETIC EVEA (University of Oviedo), led by researchers with extensive experience in educational innovation who are highly regarded both nationally and internationally. In total, there are more than 150 researchers involved in the project.

REUNI+D aims to work in line with the Open Science movement by opening up analysis to the implications, contradictions and possibilities it has for the development of research in the contemporary socio-economic context. Since 2019, it has been committed to consolidating a set of actions and procedures that help to deepen the importance of open science and education for the training of researchers and teachers in the field of education. A proposal that aims to respond to the necessary changes in the processes of production, appropriation and distribution of knowledge required by the conditions in which knowledge is produced in contemporary society.

Its work is carried out within the framework of the Networks of Excellence calls promoted by the Ministry of Science, Innovation and Universities. The project, which ran from 2019 to 2022 (RED2018-102439-T), focused on the dissemination of open knowledge and the linking of science with citizens as a first approach to the issue through the analysis of the philosophy, possibilities and problems involved in the open science paradigm, as well as the study of different repositories and platforms for sharing research resources. It also enabled training processes to be initiated for researchers in training within the network teams on the subject matter, as well as on new educational research methodologies.

In the second project, developed between 2023 and 2025 (RED2022-134187-T), the network's main objective was to delve deeper into the field of open science and its connection with citizen laboratories as work environments that stimulate the development of open knowledge through two actions:

The first was to build an open-access repository of educational research objects with data from the research of network members: research tools, data, analyses, reports, etc. *The European OSF repository* (<https://osf.io/hdg4u/>) was selected.

The second has been to take a closer look at the state of the art of citizen laboratories as generators of open knowledge, particularly in the field of education. In addition, seminars have been held to disseminate different experiences of citizen and educational laboratories. The meaning of citizen science and collaborative processes between public universities and the territory has been explored through dialogue with actors from both the local sphere and the global South.

The second objective focused on consolidating the nationally and internationally renowned community of practice and research by promoting synergies between the network's research groups and strengthening collaboration with other national and international networks. To this end, the first action was based on coordinating the network through virtual meetings with the coordinators of each of the groups that make up the network. Another action was a biannual face-to-face

meeting between network members through one of the training activities in which the network has a long tradition: the Summer Schools (summer schools for doctoral students). This strategy provides a face-to-face workspace to monitor the network's work while maintaining a training space on the network's topics and advancing this strategy together with the staff in training in the network's groups.

The second line of action to achieve this objective focuses on promoting R&D&I activities. To this end, a questionnaire was used to map the 14 groups and their active research projects in order to identify the teams available for future R&D&I calls. Two meetings were also held to exchange R&D activities, with presentations and discussions of projects and results.

The third action planned to achieve this objective is the dissemination of scientific output through the incorporation of content into the REUNI+D website (<https://reunid.eu/>), which publishes the activities carried out and a fortnightly blog. Information on the network's scientific output is also kept up to date through the *Dialnet* database and a *YouTube* channel with audiovisual content (<https://www.youtube.com/@reunid686>), in addition to a profile on the X network for the dissemination of scientific output and activities (<https://twitter.com/reunidinv>).

The third objective focuses on promoting connections with related research networks, both nationally and internationally. At the national level, REUNID is an active member of the RETINDE network (<https://www.retinde.es/>) (*Transdisciplinary Network for Educational Research*), which brings together 17 educational research networks and scientific societies in Spain.

At the international level, a white paper on educational innovation research groups in Latin America is being prepared. This approach will enable us to continue establishing working networks and connections with these research teams. This has allowed us to begin a fruitful relationship with the DAI Open Research Data Network, made up of universities in Uruguay, Argentina and Brazil, with which we have held a first seminar within the framework of LACLO 2024 (*Latin-American Conference on Learning Technologies*).

Finally, the fourth objective focuses on training and capacity building for young researchers in open science and educational innovation. To this end, four actions have been carried out. The first is the creation of an internal space for exchange among network members. The second training line of this objective focuses on webinars and seminars in an online format open to the scientific community, both on open knowledge and citizen laboratories and on the projects and research results of the network's research teams.

At the same time, face-to-face workspaces have been maintained to enable young researchers to create a community with the aim of promoting exchanges between young researchers in the network's groups. To this end, an initial approach has been made to the projects and work carried out by each group in order to gain a more accurate idea of the topics currently being developed and to facilitate this exchange of researchers, as well as a meeting between the researchers in training in the network to exchange topics and methodologies currently being implemented, thus enabling a more fluid exchange between the different groups.

2. Methodology

Within the framework of the work carried out in recent years by the REUNI+D network, this text aims to present results on the following objectives:

- a) To investigate the knowledge of the network members about the work carried out in the field of open science.
- b) To recognise the perception that members have of open science and education.
- c) To identify the obstacles encountered by members in advancing open science in higher education institutions.

To explore these three objectives, a mixed research methodology was used, combining a research design that combines quantitative and qualitative data. This methodology is considered appropriate in the case of complex social problems, which require a complex perspective (Sánchez-Escalante et al., 2022). A short questionnaire was designed and administered to all members (the average response time was 10 minutes), which provided access to the information needed to analyse their current situation and make decisions for future plans.

The questionnaire was validated through expert review and modifications were made based on the comments and recommendations provided. It consists of three sections: 1- Descriptive and demographic data (age, length of service at the institution, and level of education); 2- Conceptions and beliefs about open science. Obstacles to its development; 3- Knowledge of and involvement in the activities proposed by REUNID.

It was developed in *Microsoft Forms* with closed and open-ended questions. The former were analysed statistically using SPSS, while the latter underwent content analysis using AtlasTI 9. The validity and reliability of the questionnaire were ensured during the administration process, with a time limit for completion and no repetition of answers by members.

The categories of analysis focused on responding to the three research objectives and can be classified as follows: 1. Concepts and beliefs about open science; 2. Obstacles to the development of open science; 3. Knowledge about open science activities proposed by the network itself.

3. Results

The questionnaire was answered by 58 members of the network (38%) distributed via email, which was answered voluntarily and anonymously. Therefore, it is a consistent and representative sample of the members of the 14 teams. The selection of subjects for the sample was random, so given the high response rate, its representativeness is high. The group has an average age of 45 and 15 years of service at the institution. Most hold a PhD (88%), while 11% are in the process of obtaining one and only 2% are undergraduate students.

When asked about the definition of open science that best matches their beliefs (Figure 1), the three options with the most responses focused on promoting exchange

and collaboration, fostering accessibility, and including the entire research life cycle. Fifteen per cent associated open science with open source software and 5% with free access.

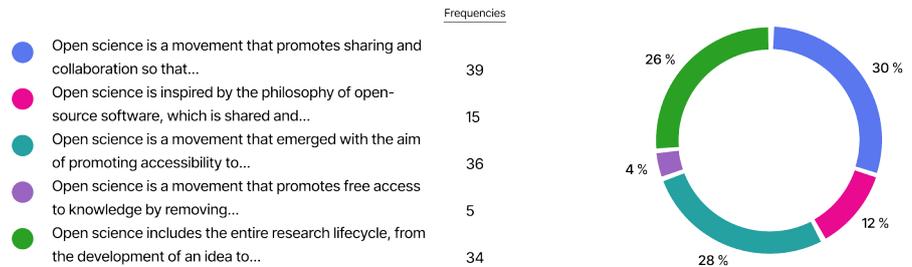


Figure 1. Definitions of open science according to beliefs.

Regarding the benefits of adopting open science (Figure 2), 24% highlight accessibility, 19% public value and integrity, 18% dissemination, and 13% promoting transfer to society.

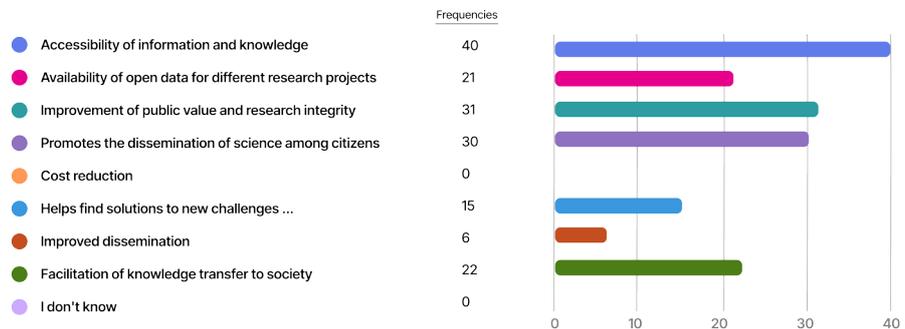


Figure 2. Benefits of adopting open science.

In relation to the difficulties (Figure 3), the contradictions in the evaluation of research stand out as the most important issue, with 23% of responses. Secondly, the lack of clear policies, with 22% of responses, and thirdly, the lack of training for the research community, with 21%. Very few consider fear of copying and fraud or loss of authorship to be a problem.

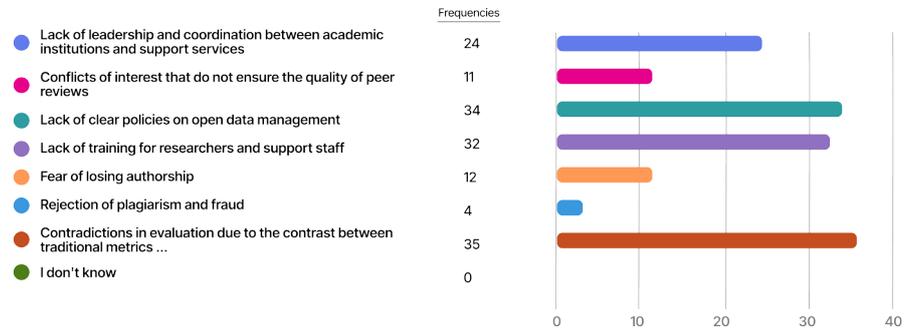


Figure 3. Main difficulties in applying open science.

The open responses were coded using ATLASTI 9 (Figure 4). Thirteen codes emerged from those relating to proposals for addressing difficulties (see Figure 4), among which the most frequent (with 10 mentions) was the need for more training. It is also important to highlight the three Cs (Coherence, Collaboration and Coordination) as a set that brings together the need for institutions to take ownership of this issue and implement policies that can help overcome it. Finally, there is a need for political participation to help drive change by proposing alternatives or manifestos that bring contradictions to light.



Figure 4. Coding open-ended questions and their density.

As for what REUNID can do about this, the majority of respondents emphasised the following: (a) Create small committees to explore specific issues in greater depth. (b) Create codes of good practice. (c) Encourage face-to-face meetings to discuss and share experiences. (d) Encourage the creation of collaborative content with manifestos and joint research projects.

Finally, the level of awareness and participation in the network's activities (Figure 5) among members who responded to the questionnaire is 50%. Only activities related to the dissemination and study of citizen laboratories show a lack of awareness and participation.

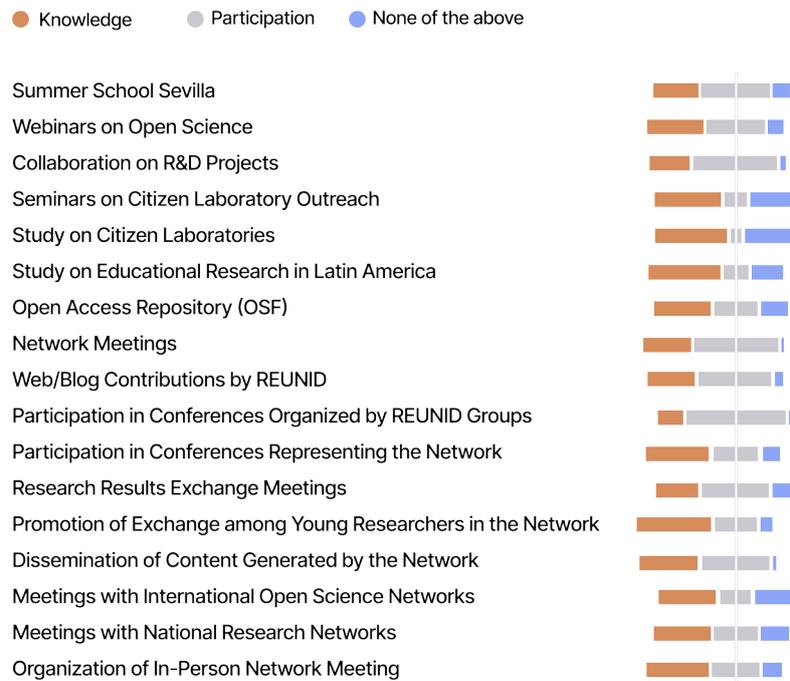


Figure 5. Knowledge and participation in activities carried out in REUNI+D during the period 23-25.

4. Conclusions

The results presented in this article show the work carried out over seven years within the framework of the REUNI+D network, while also serving as an indicator of the current state of open science in Spanish universities. They highlight the difficulties and contradictions we face in addressing the conditions of open science, despite the different regulations currently in force. REUNI+D has launched numerous activities aimed at raising awareness of the issue and encouraging open science practices in which support and cooperation can take place (Sancho Gil et al., 2022).

In this regard, it is clear that, from a conceptual point of view, there is awareness of the meaning of open science and its benefits (da Silveira et al., 2023), as well as the difficulties involved in its application and an ethical commitment to the value of science for the development of citizenship. The members of REUNI+D come from different institutions, each with its own regulations, work cultures and specific micro-political conditions, which also become apparent when defining the difficulties of integrating open science into their research practices, as there are difficulties that point to individual and institutional conditions that are important to identify in order to address them (Scheliga and Friesike 2014). This gives rise to one of the most significant

limitations faced by REUNI+D when defining its objectives. It is no coincidence that the responses with the highest percentage are those that point to contradictions in research evaluation and the lack of clear policies. In this regard, the network project has helped raise awareness of the need for what has been termed in this paper as the three Cs (Coherence, Collaboration and Coordination) as a basic axis for the work to be carried out in each institution (Ramírez-Montoya and García-Peñalvo 2018).

Finally, it is important to note that, despite the limitations of the study in terms of the number of responses obtained, it is noteworthy that 50% of the members are aware of and/or have participated in the network's activities, which is a good indicator. It would be necessary to continue working to ensure that an increasing number of members commit to and integrate the proposals promoted by the network.

As for future lines of research, we believe it would be necessary to supplement these preliminary results with other qualitative data from interviews and discussion groups that would allow for a deeper understanding of the network members' views on open science in a more complex way.

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ARTICLE / ARTÍCULO

Global citizenship and youth. Research inspired by the citizen science perspective

Ciudadanía global y juventud. Una investigación inspirada en la ciencia ciudadana

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Abstract: Citizen science enables the democratisation of knowledge and citizen collaboration in solving the global challenges we face as humanity. The participation of young people in this type of project strengthens their civic engagement and critical thinking, offering them the opportunity to become active agents of social change. In this article we present the theoretical framework and research methodology of a coordinated project of the National Research Plan that aims to promote the approach of education for global citizenship (GCE) through the involvement of young people in processes of enquiry that allow them to connect the local with the global. We aim to create scenarios where knowledge is generated from more horizontal, dialogical and shared logics, where young people can share their concerns, but also propose real actions and solutions. To this end, the YARGI (Young People as Researchers of Global Issues) methodological process has been designed based on a ten-stage method inspired by the movement of students as researchers. This research is particularly relevant in a field which has been criticised for a lack of research on how young people deal with global issues and what concerns them and moves them to action.

Keywords: Participatory Research, Citizenship Education, Qualitative Research, Global Education, Youth.

Resumen: La ciencia ciudadana permite la democratización del conocimiento y la colaboración de la ciudadanía en la resolución de los retos globales a los que nos enfrentamos como humanidad. La participación de jóvenes en este tipo de proyectos fortalece su compromiso cívico, así como su pensamiento crítico, ofreciéndoles la oportunidad de convertirse en agentes activos del cambio social. En este artículo presentamos los pilares teóricos y la metodología de investigación de un proyecto coordinado del Plan Nacional de Investigación que tiene por objetivo promover el enfoque de la educación para la ciudadanía global (ECG) a través de la implicación de personas jóvenes en procesos de indagación que les permita conectar lo local con lo global. Nos planteamos crear escenarios donde el conocimiento se genere desde lógicas más horizontales, dialógicas y compartidas, donde la juventud pueda compartir sus inquietudes, pero también proponer acciones y soluciones reales. Para ello, se ha diseñado el proceso metodológico JIRG (Personas Jóvenes como Investigadoras de Retos Globales) basado en un método de diez etapas que se inspira en el movimiento del alumnado como investigador. Esta investigación es especialmente pertinente en un campo de trabajo en el que se ha señalado que existe poca investigación empírica que permita conocer cómo se vincula la juventud a temáticas globales, qué les preocupa y les mueve a la acción.

Palabras clave: Investigación Participativa, Educación Cívica, Investigación Cualitativa, Educación Global, Juventud.

1. Introduction

Today's globalised and highly technological societies require thinking about what kind of education we need as an ethical, social and political process that enables future generations to understand the world in which they live and their role in it. International organisations such as the United Nations already contemplated in 2015 (in line with the previous Millennium Development Goals Agenda) the importance of education as one of the fundamental strategies for achieving sustainable development, intercultural understanding and the construction of peaceful societies.

As is well known, SDG4 (Quality Education) states in its target 4.7 the importance of disseminating and consolidating this educational approach which, based on theoretical and practical knowledge, enables students to understand and promote global citizenship, human rights, gender equality, cultural diversity and sustainable development. The OECD, through the PISA programme, launched in 2018 the assessment of global competence, understood as a combination of values, attitudes, skills and knowledge about global issues. Its dimensions cover issues such as an interest in intercultural communication, taking action for the common good and sustainable development, examining local, global and intercultural issues, and understanding and appreciating other people's perspectives and worldviews (MEFP, 2020).

Education systems around the world are not oblivious to the global challenges currently facing humanity, which is why there are many legal initiatives that introduce this approach at compulsory and post-compulsory education levels (Scheunpflug and Wegimont, 2024). In our country, the global citizenship approach is adopted by the current organic law regulating compulsory levels (LOMLOE, 2020) and the sustainability approach is adopted at the higher education level (Decree 822/2021 establishing the organisation of university education and the procedure for quality assurance), both initiatives aligned with the 2030 Agenda.

Despite the relevance of this educational approach in the current historical moment and the efforts of national and international organisations, the academic community has pointed out that, although there is a consolidated body of theory on what global citizenship education is (with no single meaning, but rather very diverse traditions and approaches), there is less empirical research explaining how children and young people are connected to the global issues that affect their lives and that are related to what is happening in their immediate or local environments.

There is still little research that makes the voices of young people visible and, consequently, there is little knowledge of their motivations for learning about global issues and engaging in social improvement, as well as the places and spaces in which they can develop these skills and knowledge. The literature in this field has pointed to the need to know more about where and how young people engage with global issues, how they learn about them, how they sustain their engagement over time, and how they perceive their agency in processes of social transformation (Bourn and Brown, 2011; Dolan, 2015; UNESCO, 2022; Allen, 2023; Mitsuko, 2023).

Studies that address how to address global citizenship education in formal and non-formal educational settings raise the question of which methodologies would be

most effective (Calvo-Salvador and Fueyo Gutiérrez, 2025), raising the question of the search for greater coherence between what we research and how we research it (Calvo-Salvador, 2024). At this point, research aimed at promoting global citizenship among young people should reflect on what role these young people can play in the research process itself, creating scenarios where knowledge is generated from more horizontal, dialogical and shared logics. As proposed by citizen science, it is necessary to rethink the role of citizenship in scientific activity, enabling research processes where there is room for greater participation of different sectors and social groups in scientific activity. At the same time, there are very different approaches to the scope and levels of this participation.

1.1. Our global citizenship education (GCE) and citizen science approach

In this research¹, we adopt the definition proposed by the recent European Declaration on Global Citizenship Education to 2050 (known as the Dublin Declaration) which states that GCE is education aimed at enabling young people to understand, imagine, hope and act for a world with social and climate justice, peace, solidarity, equity and equality, planetary sustainability and international understanding (GENE, 2022). This approach is known in other European contexts as global education or global learning and in Ibero-American contexts as education for planetary citizenship.

In a participatory process, the participating delegations responsible for drafting the Dublin Declaration recognise and welcome a number of developments in this field over the last twenty years, including the engagement of young people and critical reflection on colonial histories and their persistent legacy of global power imbalances. Looking ahead to 2050, they set out a series of commitments, both nationally and internationally. Of particular relevance to our research project is the commitment to strengthen the participation of diverse sectors, including youth organisations and research specialists.

This emphasis on the importance of valuing young people's experience and enhancing their participation and collaboration in research processes is in line with the philosophy behind our research design, which aims to involve young people directly in the research process. Our project seeks to promote GCE by accompanying experiences in which young people take on the role of co-researchers of global challenges, in line with the parameters of citizen science and the right to research (Appadurai, 2006).

Our project recognises the more traditional definition of citizen science as a scientific activity that seeks to generate knowledge with the voluntary participation of citizens, who decide to become involved at different levels or stages of a scientific process. The knowledge generated can be applied to solve certain social, local, environmental, etc. problems, these applications being produced outside of science itself. However, our proposal goes beyond this definition to reach a much broader vision of citizen science. Thus, as opposed to initiatives that are closer to popularisation, our concept of citizen science is concerned with generating new knowledge in a collaborative way, within the framework of a research project where decisions are made in a shared manner. The ultimate goal is to serve as a useful means to promote scientific culture (CSIC, 2022), especially among young people.

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In the same vein, this project recognises that young people have a right to research, i.e. to engage in a process of enquiry that allows them to go beyond the limits of what they already know and understand in order to make more informed decisions about issues that affect their lives, locally and globally (Appadurai, 2006). The aim is to broaden young people's horizons of knowledge and understanding by broadening their horizons of meaning in relation to the major global challenges facing humanity.

1.2. Recognising research trajectories that extend citizen science: Action Research, Citizen Labs and Critical Literacy.

Our project is inspired by previous research that has used qualitative participatory methodologies so that the people involved, whether in schools, NGOs or communities, take a leading role in the research process, participating in decision-making about objectives, methods, interpretation of results and applications of the study.

Under the umbrella of Participatory Action Research (PAR), those who investigate their own practice in order to improve it have a leading role in the whole process of enquiry. In the field of education, this tradition is exemplified by the collaboration between research specialists and teachers from educational centres to carry out an initial diagnosis to detect needs, design and implement pedagogical actions, collect and analyse data on their implementation, and finally, design improvements for future practices (DePalma, 2019).

From the community level, work inspired by the work of Colombian sociologist Orlando Fals Borda seeks to collaborate with the people directly affected by the social phenomena under investigation, as was the case of the agrarian sector in a situation of oppression within the Peasant Reserve Zones (ZRC) in Colombia in the 1990s (Gutiérrez, 2016). These are two examples (educational and community) that break with the division between scientific knowledge produced at the level of academic elites and its application to target groups or sectors. In this process, the aim is to break down the gap between the productive contexts of science and its praxis, returning the power to name, understand and respond to social problems to the people who are involved in and affected by them.

A second antecedent of our project are the citizen innovation laboratories that aim to offer spaces where citizens can come together to experiment and carry out their own projects. In this type of laboratory everything is open, as they constitute spaces that enable citizens to play a more active role in processes of knowledge production where everything is co-produced collaboratively through the interaction of people from different positions with respect to knowledge and experiential knowledge. In our view, these participatory laboratories can combine experimentation with ideas, the generation of situated knowledge and the promotion of new research practices aimed at linking young people with global challenges.

These spaces enable young people to acquire competencies for citizen participation and to develop a critical understanding of major global challenges. Youth have the capacity to not only question their environment, but also to transform it, which suggests the need for and importance of creating scenarios of participation where their voice is heard and a commitment to change is built. The youth laboratories aspire to become these spaces where young people are the ones who produce knowledge and manage to connect with the world around them. This will require a

process of deconstruction of the idea of traditional participation and the creation of spaces that involve a change of perspective and that attend to their ways of "being and participating" (Alzas, 2024).

On the other hand, it is evident that the new digital scenarios have created other forms of participation and, therefore, it is necessary to know what vision of the world young people have and how they interact with and in these new scenarios, which is why critical media and information literacy is the third pillar that has influenced the construction of our perspective of citizen science.

The rapid expansion of digital tools and the internet has led young people to make intensive use of these devices, making them the central means of accessing information on a wide range of topics (from news or purely entertainment data to other more political or social issues).

However, as some studies have suggested, young people have obvious difficulties in critically evaluating the data and information they obtain via the Internet (Valverde-Crespo, Pro-Bueno and González-Sánchez, 2022). Research aimed at identifying young people's levels of information literacy shows that the processes they use to identify and evaluate information are asystematic, selecting the first results of the searches they perform on the Internet and paying very limited attention to the reliability of the content they access (Aesaert and Van Braak, 2015; Fraga-Varela, Vila-Couñago and Martínez-Piñeiro, 2020).

Among the explanatory hypotheses for this phenomenon, one suggests that this situation occurs because, although educational legislation identifies the need to address these competences, in practice they are not developed, as there is no equivalence with the different areas of knowledge (Fraga-Varela and Rodríguez-Groba, 2019).

The development of media and information literacy processes has been a constant concern for the academic community in recent decades (Buckingham, 2015; Hoechsmann, 2019) and even for supranational bodies such as UNESCO, which has even designed a curriculum aimed at guiding teachers in the development of these processes (Wilson et al., 2011).

The aim is to enable citizens to develop the skills necessary to understand the main functions of the media, in contexts of profound media convergence, with the ultimate goal of being able to critically analyse them and use them as a means of communication (Fueyo Gutiérrez, Rodríguez-Hoyos and Hoechsmann, 2018). These strategies become even more necessary in order to try to understand and respond to the complex global problems we face today as humanity and which are the essential concern of our project.

The main objective of our research is to promote the ECG approach among young people (14-17 years old) working within the framework of the formal (secondary schools) and non-formal (organisations working with children and youth) education system. Taking into account this general objective, the specific objectives are:

- OE1. To collaboratively design research processes with young people, starting from their personal concerns and connecting the local and the global.
- OE1. To democratise research by empowering different groups (education professionals, young people) in research processes.
- OE2. To promote scientific literacy and information literacy (media and digital).
- OE3. To document the research process with young people investigating global challenges, deploying a diversity of languages such as still and moving image and dramatic expression.

2. Methodology

Our research methodology has been built on the influence of these three main traditions (PAR, citizen laboratories and critical media / digital literacy) and, as we have pointed out, it goes beyond the traditional limits of what is known as citizen science by asking how we can increase the agency of young people throughout the research process, from the initial decisions about the issues to be investigated to the decision on how to disseminate the results. It is a qualitative methodology that draws on narrative and participatory (Mannay, 2017) and inclusive (Nind, 2014) approaches to research, adopting a gender perspective (Korsvik and Rustad, 2021).

Participatory and narrative methods allow us to approach the phenomenon to be researched with the intention of understanding it in depth, enabling insights into how different groups and young people, depending on their particular characteristics (gender, age, ability, territory, etc.) shape the emergence of diverse constructions of global citizenship.

Gender-sensitive and inclusive research recognises that, as a result of the very structure of the system supporting scientific-technological advances and innovation, the homogeneity (age, gender, ability, social class, etc.) of professionals involved in research and innovation has been a fundamental characteristic for decades, which has resulted in certain research biases. These biases have been widely documented in the scientific literature and permeate the entire research process. It is precisely these gender and inclusive approaches that propose the need to correct existing gender and ability biases, proposing methodologies that take into account the diversity of human experience.

Our research is divided into three main phases. The first of these (the one we are currently working on) aims to review the state of the art of experiences that allow young people to investigate global challenges. To this end, we are carrying out an exhaustive bibliographic search and data collection with key informants (young professionals and individuals) in the three territories involved in the research (Cantabria, Asturias and Galicia). This first phase is of utmost importance to identify which global issues interest young people, how they document these, how they keep informed and what leads them to participate in social action initiatives.

All this information will be useful to articulate spaces that, as laboratories, are adjusted to their way of investigating and interpreting the world. The second phase aims to accompany and enable projects where young people can play the role of co-researchers of global challenges, based on the YARGI methodology (Young People as

Researchers of Global Issues), which we will explain below. The third and final phase of our project is aimed at evaluating, systematising and disseminating the experiences in which young people have conducted their own research, seeking the maximum diversity of languages and audiences possible and enabling political advocacy in their immediate environment.

With this general framework in mind, this project is oriented towards the development of projects where young people play the role of researchers of global challenges, which we have called the YARGI methodology (Young People as Researchers of Global Issues). More concretely, this way of working proposes a ten-step method (10E Method) that must be adapted to each context and to the particularities of the participating group.

The 10E Method is inspired by the movement of students as researchers (Bucknall, 2012; Dolan, 2015) and is designed to enable young people to go through the 10 stages that correspond to the phases of an investigation:

1. Creation of the group and decisions on the topic to be investigated
2. How to know more about what worries me
3. Methodological choices and ethical issues
4. Decisions about sample/participants and realities to observe. How to collect our research data
5. Data analysis
6. Results
7. Contrast and verification
8. Dissemination of results
9. Advocacy
10. Generating networking

The first six stages are the usual steps in any research process, with the peculiarity that in this case it will be the young people who decide what topic to research and how to do it. In the following, we will briefly describe the three stages of work that we consider to be the most innovative: Contrast and verification, Advocacy and Networking.

The Contrast and Verification stage is aimed at enabling the young participants to develop competences related to information and media literacy processes, i.e. the creation of strategies that enable this group to develop criteria for selecting, organising and verifying the information they access. These strategies become even more necessary in order to try to understand and respond to the complex global problems we face as humanity and which are an essential concern of our project. As we have noted previously, research suggests that young people have demonstrated difficulties in critically evaluating the data and information they obtain through the Internet (Valverde-Crespo et al., 2022).

The purpose of this stage in the YARGI process is to work with young people on what kind of false information and messages are circulating online and in which media (e.g. climate change denial messages, false information about migration, etc.). The aim is to contrast the results of their research with this false or denialist information, making their right to information a reality and strengthening the development of their research skills in the field of global citizenship in face-to-face and virtual scenarios. We will work

with young people on the steps to carry out these verifications (the process known as fact check) and will use specialised platforms and media (e.g. INCIBE: National Institute of Cybersecurity, European strategy for the verification of fake news, Maldita, Newtral, Learning Zone, etc.).

Another aspect that we consider novel is to raise, as a further phase of the research, the question of how to influence our immediate and distant context based on the results of our research. In this phase, we propose to work with young people on whether the results of their research can or should be made known in contexts where they have greater visibility (press, radio, etc.) and which would allow them to influence decision-making at a local or autonomous community level (city council, youth associations, Regional Ministry of Education, Directorate General for Cooperation, etc.). We will also work here on the political importance of contrasting the information that is available on the network from specialised platforms and media, underlining the importance of the right to information as a human right that is key to the freedom of thought and opinion of all people.

The last stage of the research with YARGI methodology, Networking, refers to the possibility of creating synergies with other groups, processes, projects and associations that have similar objectives to their own, as well as to the possibility of creating a network between the YARGI projects that are generated at each site. To this end, a final meeting is planned, to provide visibility for all the projects that have been carried out.

3. Results

This article is part of a four-year research project that has recently been approved (in September 2024). The first phase of the research, in which we are currently involved, aims to gain as realistic an understanding as possible of how young people research global issues. In a first step, a systematic review was conducted of the Dialnet, WOS and Scopus databases from 2020 onward using 22 terms linked to the central concept of our research: young people researching global challenges.

The preliminary results of these searches show that there is a gap in the most current publications on the role of young people as researchers on global challenges and that the studies identified focus more on how young people participate and on explaining different experiences of participation. This first preliminary result is in line with what has been pointed out by the existing scarce research in the field of GCE that particularly addresses work with young people (Bourn and Brown, 2011; Bourn, 2022; UNESCO, 2022).

In this first phase of the research we have also planned interviews with young activists and/or those involved in social causes, as well as with professionals from different fields that allow us to identify which issues linked to global challenges concern young people, how they inform themselves about these issues and what leads them to participate in social action initiatives. Two qualitative data collection instruments have been constructed: interviews, consisting of 29 questions (in the case of those aimed at young people) and 31 questions (in the case of those aimed at professionals). The dimensions addressed in the interviews are: the role of young

people as agents of change in the face of global challenges, media and information literacy, and the role of young people as researchers and citizen science.

Both interviews incorporate the photo-elicitation technique (Bautista, 2019), and the instruments are currently in the experimental application phase, i.e. an interview with professionals and another with young people is being carried out at each site, as a test to assess the instrument. Nevertheless, our research trajectory in this field (Braga Blanco and Calvo-Salvador, 2022; Calvo-Salvador and Fueyo Gutiérrez, 2025; Calvo-Salvador and Rodríguez-Hoyos, 2025; DePalma, 2019) has allowed us to understand some issues that are central to analysing the results of this project.

Firstly, that young people have a strong presence in virtual scenarios, but their civic engagement in them is very low. It is necessary to continue working on the development of digital citizenship rights with young people who are continuously exposed to fake news and hoaxes that undermine democracy and peaceful coexistence (GENE, 2022).

Secondly, an analysis of the barriers and aids to the development of the ECG approach identified by educators reveals a need to develop more participatory and creative methodologies that put young people at the centre of the educational and research process (Braga Blanco and Calvo-Salvador, 2022; Calvo-Salvador and Fueyo Gutiérrez, 2025).

Thirdly, and as a consequence of the pandemic generated by COVID-19 as well as the rapid social changes occurring worldwide, young people have great difficulty in managing the feeling of vulnerability and the breakdown of social ties with peers (UNESCO, 2022). A higher level of isolation is perceived among young people, favoured by the abuse of social networks and the interruption of face-to-face socialisation spaces. In this sense, educators point to a need to seek strategies that allow young people to reconnect with social problems and understand how they affect them, avoiding the pathologisation or individualisation of problems that have a broader dimension. We are talking, for example, about issues such as working on universal values (human rights, the right to information, the right to education, etc.) or generating a feeling of belonging to a global community. To this end, we propose expanding the creation of participatory youth laboratories as open, collaborative and inclusive production spaces where global-local issues are addressed.

Finally, the need for our research is supported not only by the results of our previous project, but also by the realisation that young people are taking an active role in addressing these major social challenges through their participation in various social movements. At the same time, there is still very little research on how to make global citizenship a learning objective, giving young people a more active role and understanding the need for a more critical use of the virtual spaces in which they participate (Bourn, 2022).

4. Conclusiones

The participation of young people in research processes and in the solution of global challenges is essential to face the challenges of our society. To this end, it is necessary to get to know and understand the youth of today's globalised society, where virtual spaces have become parallel worlds where this participation takes place.

Our proposal is to facilitate the training of young people in research projects, based on the YARGI proposal (Young People as Researchers of Global Issues), processes that allow youth to critically understand the historical moment they are experiencing and that favour the formation of more positive relationships of each young person with themselves, with other young people from proximal and distant contexts and with the reality (natural and social) that surrounds them.

The proposal of our project is to create different spaces according to the territory and characteristics of the participating group that, like the citizen laboratories, allow young people to move from protest to proposal, where they can experience other ways of doing, naming and relating, facilitating the knowledge of what motivates and moves them and expanding their possibilities of participation in everything that affects their lives.

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ARTICLE / ARTÍCULO

Rethinking Global Citizenship through Open Science. The Challenge of Game-Based Collaborative Research with Young People

Repensar la ciudadanía global desde la ciencia abierta. El desafío de co-investigar mediante el juego con personas jóvenes

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Abstract: A participatory research process framed within the open science paradigm was undertaken to explore how young people understand and engage with global citizenship in the context of the current severe socio-ecological crisis. Using a co-design methodology, the collaborative game *Global Quest* was conceived as both a citizen science research tool and an open educational resource. Inspired by ludo-pedagogical principles, it has been made available to education professionals to use when working on global citizenship themes. The game was test run on 15 occasions with approximately 400 participants, including both adolescents and professionals working in the socio-educational field. The game's tasks were refined with the help of qualitative observations collected using structured guides. This improved the balance between local and global themes, as well as between reflective and expressive activities. Analysis of the observed data revealed that the game encourages young people to express their perspectives on participation, diversity, sustainability, and rights. It also promotes critical reflection on global citizenship and fosters inclusive, collaborative dynamics. The process confirmed the significant potential of the game as both a pedagogical tool and a research tool. It is also suitable as a participation strategy for addressing social challenges creatively. Additionally, the materials for the game, the accompanying manual, and a didactic guide providing methodological guidelines for use in diverse educational contexts have been developed and shared openly.

Keywords: Global Education, Citizenship Education, Game Based Learning, Open Science, Participatory Research.

Resumen: Este artículo describe un proceso de investigación participativa enmarcado en el paradigma de ciencia abierta, para indagar cómo los jóvenes entienden y ejercen la ciudadanía global en el momento actual caracterizado por una grave crisis ecosocial. Mediante técnicas de codiseño se creó el juego colaborativo *Global Quest*, concebido simultáneamente como herramienta de investigación desde la ciencia ciudadana y como recurso didáctico abierto inspirado en la ludopedagogía, a disposición de los profesionales de la educación para trabajar temas de ciudadanía global. El dispositivo se puso en práctica en 15 ocasiones con aproximadamente 400 jugadores, adolescentes y profesionales de la intervención socioeducativa. Las observaciones cualitativas recogidas a través de diversas guías nos permitieron reelaborar las pruebas, introduciendo mejoras en el equilibrio entre lo local y lo global en las temáticas, así como entre pruebas reflexivas y expresivas. El análisis de las observaciones recogidas evidenció que el juego favorece la expresión de perspectivas juveniles sobre participación, diversidad, sostenibilidad y derechos, potencia la reflexión crítica sobre la ciudadanía global y genera dinámicas colaborativas inclusivas. Este proceso confirmó el potencial del juego como herramienta pedagógica y de investigación, así como su idoneidad como estrategia de participación para abordar problemas sociales de forma creativa. Se ha elaborado y compartido de forma abierta el material del juego, su manual y una guía didáctica que ofrece pautas metodológicas para aplicarlo en diversos contextos educativos.

Palabras clave: Educación Global, Educación para la ciudadanía, Aprendizaje basado en juegos, Ciencia abierta, Investigación participativa.

1. Introduction

As part of the «Building Global Citizenship with Young People»¹ and «Participatory Research in Global Citizenship Labs for Young People»² research and development projects, we developed a research and co-design strategy based on open science principles. These projects are a way of generating knowledge through participatory, collective, and open research with various stakeholders—primarily young people, but also teachers and other education professionals.

Our research began with a preliminary mapping of global citizenship initiatives in Asturias, Spain (Fueyo et al., 2023). This work was an attempt to understand how adolescents construct global citizenship. Here, global citizenship is defined as a form of citizenship that transcends nation-state belonging in favor of awareness of, and action in response to, the global challenges of today's eco-social polycrisis (Andreotti, 2021 & 2024; Prieto-Jiménez, 2020; Rodríguez-Izquierdo & García-Bayón, 2024; Stein, 2021).

This was achieved by adopting open science as both a participatory and democratic model of inquiry and a strategy to amplify the voices of young people throughout the research process (Abadal, 2021; Fecher & Friesike, 2014) and co-design phase (Design-Based Research Collective, 2003; Kleinsmann & Valkenburg, 2008; López et al., 2021). Unlike citizen science, which only involves citizens in data collection, this approach expands citizen involvement to encompass every stage of the research process. It fundamentally reshapes how research is conducted, who conducts it, and its purpose (Abadal, 2021; Escofet et al., 2021; Fecher & Friesike, 2014).

For us, engaging young citizens meant negotiating meanings, values, and expectations with a wide range of stakeholders. This approach challenged traditional knowledge hierarchies (Design-Based Research Collective, 2003) and questioned the institutional and political parameters that determine what constitutes valid knowledge. Ultimately, it challenged and redefined the traditional roles of both researchers and research subjects.

The methodological device was conceived as a bridge between knowledge and action, which enabled us to bring together theoretical and practical insights from a range of individuals in settings that extended beyond purely academic spaces. Consistent with previous studies (Calvo & Fueyo, 2025; Rodríguez-Hoyos et al., 2023), we rejected traditional research methods that focus on the knowledge held by researchers and its application to participants who tend to be viewed as passive objects lacking meaningful knowledge about the topic under investigation. For this reason, we chose to include groups that are often excluded from research—in this case, adolescents and young people—as active co-participants in the research process (Fueyo et al., 2024).

One of our methodological goals was to alter perceptions of young people in relation to global challenges. We aimed to provide a more positive and hopeful outlook than that typically projected by adult researchers onto this group. Our objective was to

¹ «La construcción de la ciudadanía global con personas jóvenes. Investigando prácticas transformadoras con metodologías participativas e inclusivas». PID2020-114478RB-C22 Proyecto financiado por MCIN/AEI /10.13039/501100011033.

² Investigación participativa en laboratorios juveniles de ciudadanía global. PID2023-146088OB-C32 Proyecto financiado por financiado por MICIU/AEI/10.13039/501100011033/ y por FEDER/UE.

position young people as key contributors to the various stages of the research process, starting with the design phase itself and the selection of data collection techniques.

Adopting an open science approach meant relinquishing the epistemological monopoly typically granted to researchers. This allowed for the incorporation of voices and experiences from the buffer zone between theory and practice. Despite the apparent novelty of this approach, it is important to note that many of its underlying principles are not entirely new to the field of education. The relationship between theory and practice, the necessity of researching from and with the perspectives of those at the heart of processes, and the pursuit of transformative, collaborative knowledge are all deeply rooted in the traditions of critical pedagogy and participatory action research.

These ways of thinking have been increasingly absent from conventional academic discourse lately. However, they resurface when the epistemological monopoly is disrupted and young people's voices are finally heard. Nevertheless, these approaches are not without controversy, particularly in relation to questions of validity, credibility, legitimacy, and bias. For example, it is argued that co-production may undermine the researcher's critical faculty, or that emotional involvement with participants may compromise objectivity and the generalizability of findings (Perry, 2022; Strasser et al., 2019).

Notwithstanding these arguments, we contend that the openness afforded by the combination of co-design and open science has enabled us to overcome pessimistic assumptions about the imaginations of young people, paving the way for more hopeful forms of action, the creation of open-access materials, and learning informed by situated dialogue. In our view, far from diminishing the depth of research, these methodologies have been instrumental in consolidating forms of inquiry that are more relational, ethical, and contextually relevant.

As Perry (2022) argues, co-production not only expands the field of knowledge but also redefines what constitutes valid knowledge within a framework of open, equitable, and democratic science. This approach goes beyond merely including a diverse range of voices. In our case, it pushes us to develop new ways of relating to young people and the institutions that support them, helping us build more sustainable relationships based on reciprocity and mutual recognition.

In this sense, our commitment to co-design and co-production through the lens of open science is as much an ethical and political stance as it is a methodological choice (Vallejo-Sierra et al., 2023). In today's context, it implies acknowledging that the potential for social transformation is not confined to predetermined or singular paths. This commitment led us, albeit unintentionally, to adopt a game-based approach to inquiry at the suggestion of the adolescents themselves.

Our decision to use games as a participatory and inclusive method of inquiry emerged from a session with a group of teenagers from the Los Glayus Association (2021)³ with whom we began holding workshops on global citizenship at the outset of our research project. Participants challenged traditional research methods by calling

³ <https://asociacionlosglayus.org/>

for new, more participatory, inclusive, and creative ways to explore what adolescents think and feel.

There is no doubt that games are a powerful educational tool. They allow children to safely explore their environment and learn the rules of social interaction without facing serious consequences (Whitaker, 2024). Educational research has shown that games positively influence key areas such as motivation, socialization, communication, self-expression, and engagement with the surrounding environment (Brown, 2010; Garrido-Sánchez & Crisol-Moya, 2023; Quiñones et al., 2025; Varas et al., 2023).

Collaborative games have enormous inclusive potential, allowing everyone to participate regardless of their diversity background, and create a space where emotions and rational thought can co-exist. These qualities are essential for addressing complex issues such as today's global challenges. Collaborative games can also be used as research tools (Gómez, 2015), as was the case in our study.

However, besides their potential as a tool for achieving instructional or competency-based objectives, we see games as an inspiring and creative activity. Rather than playing games to achieve a specific learning outcome, we emphasize the value of playing games for their own sake, placing the game itself front and center without predetermining the outcome.

According to María Rivasés (2017), playing games requires us to suspend our cognitive, cultural, social, emotional, and sensory frameworks and immerse ourselves in a new, playful reality that is different from our everyday lives. This is something we do voluntarily. No one can be forced to play games, just as no one can be forced to learn. It is therefore essential to create an environment that is conducive to entering this new space, which is where the role of game facilitators becomes key.

This playful reality involves stepping into a realm of both personal and collective uncertainty, one shaped by ongoing negotiation between the players. It is an ideal shared space for co-creation where adolescents can freely express themselves and participate. Games are unique each time they are played because they provide a blank canvas by their very nature (Rivasés, 2017). This is genuine participation in its purest form. The goal is for group members to immerse themselves in this singular and playful reality and take some or all of their experiences from this space into their everyday lives. We play the game, and then we reflect on what happened and generate new ideas for activities or courses of action in order to continue exploring or addressing the issues that affect us (Braga et al., 2025).

In the field of ludo-pedagogy⁴ it is argued that games provide a means or pathway through which we can learn about the world. The goal is to acquire knowledge in order to transform reality and create a world or rather, multiple worlds, in which equity, justice, freedom, and happiness prevail. This approach aligns with the ethos and goals of what is traditionally known as Popular Education, a concept pioneered by educator Paulo Freire, in which games are used as a fundamental tool to achieve these goals (Castelo, 2023). Consequently, ludo-pedagogy pursues the idea of

⁴ The La Mancha Center in Uruguay is a leading reference in the field of ludo-pedagogy: <http://www.mancha.org.uy/#/-en-un-lugar-de-la-mancha/>

«playing to learn, learning to transform» (Castelo, 2023, p. 16). It involves thoroughly exploring reality from every possible angle with the aim of transforming it.

Of the many methodological approaches that incorporate games, it is our view that critical game-based learning is one of the most closely aligned with the principles of global citizenship education (GCE) (Castelo, 2023). It provides playful, experiential educational resources that encourage participants to explore a wide range of perspectives on and facets of reality in a collaborative, complementary, and, of course, creative manner (Los Glayus Association, 2021).

2. Methodology

Our co-design process began in 2021 with a workshop called «What Are We Worried About?» The workshop was attended by adolescents aged 12-16 who belong to Asturian municipal child and adolescent participation groups which are part of the Los Glayus Association. We used an adapted version of the activity described in James Beane's (2005) book, which produced an unexpected map of concerns.

This enabled us to refine the dimensions and categories of GCE that we had previously been working with from an academic perspective. It also offered insights into which research tools to use to explore how young people navigate the challenges of global citizenship (Calvo & Fueyo (coord.), 2025). This workshop sparked the idea of using games strategically to encourage adolescents to freely express their thoughts and emotions about complex and challenging global issues in a safe, spontaneous, and active way.

From that point on, our team began collaborating on the design and development of a participatory game as an alternative to other commonly used research techniques. The game brought together a variety of GCE-related challenges that met the criteria established by the adolescents. Several experimental prototypes were developed and then tested by young people and professionals from various backgrounds (school and social) to refine and perfect the content, dynamics, materials, and so on. The co-design methodology used to create this game aimed to answer questions such as: How can we most effectively explore the ideas, concerns, feelings, and fears that adolescents have about global challenges and their effects? What concerns them on personal, local, and global levels? Do they feel involved in global issues? If so, in what way? What do they know and feel about these issues?

From its initial design phase, the game was tested extensively, being played numerous times over a period of more than two years in a wide variety of settings. Between 2003 and 2025, it underwent 15 rounds of testing and was tried out by over 400 people from a variety of backgrounds (see Table 1).

- Adolescents and young people from high schools, participation groups for children and young people, vulnerable groups from social organizations, and those attending university extension programs.
- Educational and social professionals, through the delivery of various training workshops.

- Young professionals in training, through undergraduate and master’s degree courses at the Faculty of Teacher Training and Education.
- The general public, during two editions of the European Researchers’ Night at the University of Oviedo, as well as a Storytelling event hosted by the Faculty of Teacher Training and Education.

Table 1. Pilot sessions of the newly developed game.

Date of the pilot session	Groups	Organization
2023	Adolescents aged 12 to 16 from the Castrillón Children’s Participation Group <i>Los Cotorros</i> .	Los Glayus Association
2023	Education professionals from various sectors participating in the Multiplier Event of the R&D project, <i>Global Citizenship and Social Transformation: Current Challenges in Education</i> .	<i>Global Education</i> Research Group (Cantabria) and IETIC EVEA Research Group (Oviedo). Summer courses and extension programs at the University of Cantabria.
2023 y 2024	Adolescents aged 12 to 18 from the «GAM» Adolescence Group.	Mar de Niebla Foundation.
2023	Compulsory Secondary Education students.	Rosario Acuña High School (Gijón).
2023	Compulsory Secondary Education students.	Fernández Vallín High School (Gijón).
2023 y 2024	Attendees at two editions of the <i>European Researchers’ Night</i> .	University of Oviedo.
2023	Students, teachers, and audience members attending the <i>Storytelling</i> event for the Bachelor’s Degree in Pedagogy.	Open Assembly of Education Students at the University of Oviedo.
2023 y 2024	Students enrolled in the <i>Education for Cooperation and Sustainable Human Development</i> course as part of the Bachelor’s Degree in Pedagogy	Faculty of Teacher Training and Education – University of Oviedo.
2024	Young People aged 17-30 from the Medialab <i>Global Shared Citizenship. A space for young people to participate and co-create for global citizenship</i> .	IETIC EVEA Research Group. University of Oviedo university extension program Los Glayus Association
2024	Students enrolled in the <i>Master’s Degree in Intervention and Socio-educational Research</i> at the University of Oviedo.	Faculty of Teacher Training and Education – University of Oviedo.
2025	Professionals from the course <i>Participatory approaches and methodologies in global citizenship education</i> .	Avilés Teacher Training and Resource Center - West, IETIC EVEA Research Group, Asturian Cooperation Agency and <i>Global Education</i> Group of Cantabria.
2025	Compulsory Secondary Education students.	Valle Aller High School (Moreda).

During each session, the facilitators systematically gathered information using various observation guides. An initial template was used to collect observations and suggestions for improving the game's dynamics, the facilitators' roles, how the topics and materials were used, and the design of the instruction cards for the challenges.

The intention was to gradually introduce changes and improvements to the game based on the players' feedback. Information was also gathered on each challenge or task in the game, including players' reactions and suggestions for improvement.

At the same time, a template was designed to document how the groups interacted and participated in light of the inclusion/exclusion dynamics that were a feature of the game.

Table 2. Observation template for inclusion dynamics. Source: Braga & Fueyo, 2025b, p. 25.

Inclusion dynamics	
Elements of analysis	Observations
Group distribution of the adolescents during the activities.	
Marginalization or exclusion of certain individuals by the group.	
Adolescent interaction, including mutual support and co-operation.	
Active participation or non-participation of all adolescents in the game.	
Atmosphere of respect and acceptance of individual differences.	
The group's ability to take advantage of individual differences.	

Each pilot session lasted one hour, followed by a 30-minute reflection session with the players about what happened during the game. The template in Table 3 was used to collect data on the contributions made during this final stage.

Table 3. Template for gathering feedback from the post-game discussion. Source: Braga & Fueyo, 2025b, pp. 23-24.

Closing discussion with participants about the game	
A) About the structure of the game	Did you find it EASY or DIFFICULT to understand? Did you find it ENTERTAINING or BORING? Did it seem LONG or SHORT to you? What did you think was MISSING, and what do you think was UNNECESSARY? Suggestions for improvement? What would you change? Do you think the game is suitable for young people between 12 and 18 years old?

Closing discussion with participants about the game	
B) About how the game unfolded in this group	How did it make you feel? What did you like best? What did you like least? What topics or issues did you associate with the activities? Which of these topics concern or interest you the most? Why? Do you think this game has anything to do with REAL LIFE? In what way? Can you give an example? Is there anything that happened during the game today that inspires you or motivates you to make a change in your life? What? What do you think the game has to do with the idea of citizenship? How do you rate the role played by the facilitators?

3. Results

After several test runs and revisions to tasks within the game and the methodological guidelines, the final version was released to the public under the title «*Global Quest: What are we doing on the planet?*» (Braga & Fueyo (coord.), 2025a, 2025b).

The full open-access kit includes a game manual with detailed instructions and a list of all the necessary materials, as well as a complementary teaching guide that provides methodological guidelines to support independent use by professionals in socio-educational settings.

All materials are available under a Creative Commons license. In keeping with the open science principles outlined in the introduction, these materials are intended to be an evolving resource. Suggestions for new tasks and ideas for improvement are welcome from young people and professionals alike. We are committed to sharing

contributions of this nature on the website, where all game materials and complementary resources are publicly available⁵.

Global Quest is a collaborative game designed to be played in 90-minute sessions. The game is organized into two distinct phases. One hour is dedicated to playing the game and completing various tasks. This is followed by 30 minutes of discussion and reflection on what took place during the game. The game is recommended for six to 16 participants, ideally between the ages of 12 and 18.

The game is played on a board made up of six islands and a central atoll. Each island is associated with a specific challenge or task. For each task completed, the corresponding island is colored in. The ultimate goal of the game is to color in all of the islands so as to «save the planet.» The tasks focus on four broad thematic areas relating to global citizenship, as identified by the young participants during the co-design process:

- a) Human diversity.
- b) Human and social rights.
- c) Environmental sustainability.
- d) Democracy and participation.

The format of the challenges combines reflective and discussion-based tasks with others involving physical and artistic expression. This approach is intended to incorporate a variety of expressive forms within each challenge (see Table 4).

Table 4. *Global Quest* tasks as they relate to the thematic areas of CGE. Source: Braga & Fueyo, 2025b, p.9

	Human diversity	Human and social rights	Environmental sustainability	Democracy and participation
Physical tasks	Statues that come to life	Are we the same?	Guess the endangered species	Communities vs. multinationals
Reflexive tasks	What do you see in the picture?	The great big negative thoughts factory	Heal the Earth	What do I do on social media?

In line with the principles of open science and game-based learning, the materials provide an opportunity to address any relevant gender and diversity factors, while examining the role of virtual environments in shaping young people's imagination and behavior in relation to global citizenship.

The aim is to avoid oversimplifying something that is inherently complex. In line with critical decolonial pedagogies, the game makes it clear that «saving the planet» is undoubtedly the most challenging task facing humanity today. As in real life, no one can accomplish this alone or fully overcome the challenge. Players must collaborate to solve problems and make decisions by consensus.

⁵ <https://www.uniovi.es/grupoetic/global-quest/>

Although players can color in several islands during a single game, it is impossible to color in (and therefore «save») the entire planet within the allotted time. The tasks are not easy, and the game avoids oversimplifying its messages. Nor is the aim to promote a sense of hopelessness.

For this reason, the various test runs have resulted in recommendations for facilitators to include real-life examples of people who have organized and achieved changes, both small and large, in their communities. Accordingly, in addition to the pedagogies of unrest proposed by decolonial approaches to global citizenship education (Andreotti, 2024; Organization of Ibero-American States for Education, Science, and Culture [OEI], 2022), the game draws on the principles of Paulo Freire's (1993) *Pedagogy of Hope*.^T

The combination of Freire's ideas and contemporary environmentalist perspectives (Goodall & Abrams, 2022) is crucial in addressing the lack of mobilization and organization resulting from young people's pessimism regarding the possibilities for transformation (Andreotti, 2021 & 2024; Pashby et al., 2020; Stein, 2021). This, as we will see, is one of the most significant findings of our research.

It stands to reason that each professional should feel free to customize the tasks within the game according to their own skills and circumstances. Furthermore, the process does not have to end once the game is over. The learning experience can serve as a springboard for exploring major global citizenship issues further through new activities. The facilitators and adolescents work together to decide which additional activities to carry out next.

We do not see the game as an end in itself, but rather as a starting point to spark young people's interest in addressing the challenges facing our planet. Specific sessions can be devoted to designing new challenges for other young people, which the adolescents can then lead.

Ultimately, this material can serve a dual purpose. It can be used to explore adolescents' thoughts on global citizenship and to initiate and implement educational activities, whether curricular or community-based.

4. Conclusion

A qualitative analysis of the observations gathered during the game's test runs identified four areas where the game could be improved compared to the initial version (see Tables 2 and 3).

- a) When dealing with issues of global citizenship education, it is necessary to integrate both local and global perspectives (Rodríguez-Izquierdo & García-Bayón, 2024).
- b) The initial versions predominantly featured reflective tasks. It was then necessary to incorporate expressive tasks, such as movement, theater, art, and creative exercises, to encourage emotional expression and critical thinking (Los Glayus Association, 2021).
- c) To combat pessimism and feelings of despair among young people, it is important to incorporate inspiring experiences that allow facilitators to share

positive, real-life examples of overcoming global problems (Goodall & Abrams, 2022; Klein & Steffoff, 2021).

- d) Facilitators must adopt a flexible approach. They need to be able to gauge the mood and emotions of the group and adapt accordingly. To that end, methodological guidelines are included with the game materials to encourage a flexible approach to group facilitation. Particular attention should be given to how adolescents are grouped during activities, how they interact with one another, the overall atmosphere and mood of the game, and how the group capitalizes on individual differences, among other things (Rivasés, 2017).

Qualitative analysis of the observed data allowed us to identify significant patterns regarding the expectations, anxieties, opportunities, and difficulties that young people face when developing critical global citizenship. According to Humphry et al. (2023), the relationship with digital environments is a key factor in how young people engage with and imagine the global world. The observed data were analyzed in depth to explore the link between young people, virtual environments, and global citizenship. The findings reveal that adolescents are mostly passive participants on networks such as TikTok, Instagram, and Twitter/X. Young people primarily use these platforms for entertainment, to keep in touch with friends, and to follow influencers. Activities related to digital activism or critical information were scarce, and digital spaces were viewed as places of escape rather than as spaces for political action (Fueyo et al., 2025).

During the course of this experience, adolescents often expressed feelings of helplessness in the face of global problems. They pointed to the influence of algorithms and the ephemeral nature of activist virality, as evidenced by the war in Ukraine, where the initial social media impact quickly faded from young people's digital profiles. They also mentioned the symbolic pressure placed on them by adults: «They ask us to change the world, yet they don't listen to us.»

Although some examples of digital activism were identified, such as sharing content about mental health or feminism, they were the exception rather than the rule. Our findings suggest that digital environments encourage spectator citizenship more than participatory citizenship. This poses a challenge for educational transformation.

The roll-out of *Global Quest* provided valuable insights into how young people understand global challenges and how participatory spaces can be revitalized. Qualitative analysis of the interactions revealed that the game created a meaningful space that bridged the gap between theory and practice. This was accomplished by encouraging the researchers to relinquish their epistemological monopoly. This space allowed young people to reflect collectively on social, environmental, and emotional issues from a personal, contextualized perspective.

One of the most notable outcomes was the game's ability to trigger processes that reframe local and global realities. Throughout the tasks and discussions, participants expressed concerns about the ecological crisis, gender inequality, and the psychological effects of the current socio-economic model. These concerns echoed the issues raised in other studies (Stein, 2021; Stein et al., 2024) and arose from the topics discussed and the manner in which arguments were presented, highlighting connections between personal, collective, and structural dimensions.

An analysis of participants' interactions during certain tasks, such as «Heal the Earth» and «Communities vs. Multinationals,» reveals that, despite their limited understanding of global processes in some cases, participants were able to identify the actors involved and the far-reaching social consequences. Of particular note is the task titled «The Great Big Factory of Negative Thoughts.» This activity demonstrated young people's capacity to challenge imposed social norms, reject materialistic ideological frameworks, and exhibit transformative creativity beyond typical adult-centric perceptions of the youthful imagination.

A highly significant and recurring phenomenon was also observed during this process: the difficulty that adolescents have in trusting collective action as a means of transformation (Klein & Steffoff, 2021). Although the game sessions encouraged expressions of commitment and agency through an open science approach, they also allowed feelings of skepticism, mistrust, and powerlessness in the face of major global challenges to come to the fore. The tension between the desire for change and the perception of ineffectiveness is a key finding that underscores the importance of integrating these types of educational experiences into broader institutional and community processes. In this sense, our proposal falls within the critical tradition of depth education, as defined by scholars such as Andreotti (2021; 2024). This approach involves asking uncomfortable questions, problematizing frameworks of expression, and taking on ethical responsibilities in the face of global inequality.

One notable finding is that most adolescents are not actively engaged with global citizenship issues. This may be due to a lack of appropriate contexts and frameworks for engagement, as some studies suggest (Rowland et al., 2024). Social media use is predominantly passive, focusing on consumption rather than digital activism. Pressure from adults and pessimism emerged as factors hindering young people's sense of agency.

It is extremely difficult to effectively implement the right of children and adolescents to participate (Novella & Llana, 2024). For this reason, we are interested in observing the dynamics of participation in groups of young people from an inclusive perspective. Despite its participatory nature, the real-life implementation of the game revealed certain limitations that require critical consideration.

First, imbalances in participation dynamics related to inclusion were identified, indicating the need to review accessibility criteria to ensure the full participation of adolescents with disabilities. Likewise, there were gender disparities in terms of the types of participation exhibited by adolescents. The sessions revealed a clear pattern: girls tended to lead reflective and discursive activities, while boys tended to take on practical or action-oriented tasks. This pattern suggests that certain role expectations influence how young people position themselves within the game space, thereby perpetuating gender stereotypes that remain prevalent in contemporary society.

These two issues demonstrate that the game space, though designed as a tool for critical and collaborative exploration, is not immune to the structural tensions of the society in which it exists. The design, facilitation, and observation of the process must be reviewed with an even greater focus on diversity and the socio-cultural factors influencing young people's real and symbolic participation.

4.1. Final reflections

Global Quest emerged from a cyclical process of development, validation, and reformulation carried out in collaboration with adolescents and educators. This process adheres to the iterative co-design paradigm (Design-Based Research Collective, 2003) and an epistemological framework that champions democratic, critical, and collaborative forms of knowledge production, consistent with the principles of open science (Abadal, 2021; Fecher & Friesike, 2014).

In keeping with the tradition of critical game-based learning (Castelo, 2023), the resulting game is not conceived as entertainment or training. Rather, it is designed to be a space and opportunity for emotional expression, critical reflection, and agency. It moves beyond passive citizenship by inspiring a desire for involvement, deliberation, and transformation. Its modular structure and systematic documentation of experiences ensured the ongoing improvement of the materials and their alignment with the project's participatory goals.

The experience of playing the game demonstrated its potential as an investigative game-based tool and educational catalyst. The process enabled an exploration of young people's conceptions of global citizenship by engaging their emotional, cognitive, and political dimensions. The combination of expressive, playful, and dialogic activities encouraged active engagement and critical dialogue, thereby reinforcing the value of games as research and educational tools. However, its ability to effect real change hinges on the institutional ecosystem in which it is used.

As we observed during the game's test runs, encouraging critical thinking and global awareness among young people requires continuous support from different social spheres. Public policies, community groups, and networks must play an active role in fostering youth engagement and creating environments that encourage genuine participation, where the voices of adolescents are heard, valued, and translated into collective action.

The findings underscore the importance of establishing and sustaining spaces that encourage ongoing youth participation. This experience demonstrates adolescents' ability to think critically, yet also reveals their susceptibility to skepticism about collective action. One possible future course of action is for young people to design new tasks that address emerging concerns, such as mental health, as well as new issues in digital environments, such as the rise of artificial intelligence technologies.

Moving forward, the co-design process should prioritize establishing collaborative networks that encompass educational communities, public institutions, social organizations, and youth groups. Such networks will ensure that these processes are sustainable over time. It is important that the progress made in the game continues beyond the game itself. For this reason, we believe that co-designed materials should not be viewed as an end in themselves or as finished products. Instead, they should be seen as catalysts that pave the way for new, transformative, and contextually-based educational practices.

The research we conducted reinforces the need to extend the implementation of *Global Quest* to diverse geographical and institutional contexts. This would enable

us to compare the game's applicability, adaptability, and appeal in different educational and social environments. We believe it is essential to encourage adolescents to create their own new tasks. Doing so would enrich the game's creative potential and establish it as an open platform for contextualized research. This plan of action must be grounded in hope. Although global challenges are complex (Stein et al., 2024), it is possible for a transformative citizenry to emerge through collective effort, empathy, and shared creativity.

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ARTICLE / ARTIGO

Citizen Science and Educational Technology for Open Science: An Experience of Co-creating Knowledge with *iNaturalist*

Ciência Cidadã e Tecnologia Educacional para a Ciência Aberta: Uma Experiência de Co-criação de Conhecimento com o *iNaturalist*

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Abstract: This article describes the implementation of a Citizen Science project focused on the collaborative creation of a field guide to the birds of the campus of the Federal University of Santa Catarina (UFSC). The initiative, developed by the Laboratory of Ornithology and Bioacoustics of Santa Catarina (LABOAC/UFSC) in partnership with the Laboratory of Production, Communication and Scientific Memory (CienLAB/UDESC), aimed to promote birdwatching, encourage environmental education, and involve the academic and external community in scientific activities. The methodology included field trips, collection and curation of photographic records, drafting descriptive content, and organizing this data in a digital repository on the iNaturalist platform. The results demonstrated the potential of digital tools to strengthen Citizen Science by enabling broad public participation in the production and validation of scientific knowledge about local birdlife. The experience also revealed challenges, such as information curation and maintaining community engagement. The project reinforced the importance of citizen participation in scientific initiatives, particularly in biodiversity and conservation. The publication of the guide, in both print and digital formats, contributes to valuing the campus as a space for research, recreation, and environmental education, while exemplifying the transformative role of Citizen Science in knowledge construction and in strengthening the relationship between science and society.

Keywords: Open Science, Informal Science Education, University Outreach, Biodiversity, iNaturalist.

Resumo: Este artigo relata a implementação de um projeto de Ciência Cidadã focado na elaboração colaborativa de um guia de campo das aves do campus da Universidade Federal de Santa Catarina (UFSC). A iniciativa, desenvolvida pelo Laboratório de Ornitologia e Bioacústica Catarinense (LABOAC/UFSC) em parceria com o Laboratório de Produção, Comunicação e Memória Científica (CienLAB/UDESC), teve como objetivo promover a observação de aves, fomentar a educação ambiental e envolver a comunidade acadêmica e externa em atividades científicas. A metodologia envolveu saídas de campo, coleta e curadoria de registros fotográficos, elaboração de conteúdo descritivo e a organização desses dados em um repositório digital na plataforma iNaturalist. Os resultados demonstraram o potencial das ferramentas digitais no fortalecimento da Ciência Cidadã, ao permitir a ampla participação do público na produção e validação de conhecimento científico sobre a avifauna local. A experiência também evidenciou desafios como a curadoria das informações e a manutenção do engajamento comunitário. A experiência reforçou a importância da participação cidadã em projetos científicos, especialmente nas áreas de biodiversidade e conservação. A publicação do guia, em formato físico e digital, contribui para a valorização do campus como espaço de pesquisa, lazer e educação ambiental, ao mesmo tempo que exemplifica o papel transformador da Ciência Cidadã na construção do conhecimento e no fortalecimento da relação entre ciência e sociedade.

Palavras-chave: Ciência Aberta, Educação Científica Informal, Extensão Universitária, Biodiversidade, iNaturalist.

1. Introduction

1.1. Citizen Science, Open Science and Environmental Education

Citizen Science can be broadly defined as the active and voluntary participation of non-scientist citizens in the production of scientific knowledge. The term generally refers to the interactions and partnerships between researchers and members of the general public in the collection and analysis of scientific data (Martins & Cabral, 2021). It is closely related to Open Science since it integrates civil society into scientific practice, aligning with democratic principles such as open access to publications, data, and education (Romero, 2017; Silveira & Bisset-Alvarez, 2024). Traditionally, Citizen Science brings citizens closer to public-interest topics, such as environmental and social causes, thus fostering environmental education and awareness of ecological issues (Martins & Cabral, 2021; Santos et al., 2022; Gama & Santos, 2024). This collaborative model has gained prominence in various fields of knowledge, especially those requiring a high volume of field observations, such as studies on the distribution patterns of organisms, becoming an important tool for biodiversity conservation research by expanding research reach (Dickinson et al., 2010; Martins & Cabral, 2021; Santos et al., 2022; Alvim & Silva, 2022).

In the context of digital platforms, Citizen Science and Open Science converge in initiatives that facilitate collaboration between citizens and researchers, creating a more integrated and participatory research environment. This approach broadens access to research stages, involving the public in activities such as data collection, analysis, and description (Gama & Santos, 2024). This type of participation is connected to Responsible Research and Innovation, promoting social inclusion and enriching scientific knowledge (Silva et al., 2023). Species monitoring projects, such as those conducted by natural history museums or birdwatching apps like eBird, exemplify how public participation enriches biological research and promotes environmental conservation (Martins & Cabral, 2021; Santos et al., 2022).

Moreover, Citizen Science strengthens university outreach projects, such as citizen laboratories (e.g., LECA in Brazil), which integrate academics and communities in research on socio-environmental issues (Witt et al., 2023). These initiatives generate scientific data and innovation in a wide range of areas, including agricultural biotechnology (Witt et al., 2023; Silva et al., 2023), fauna monitoring (e.g., aVerAves), and public health (e.g., “Ciência que se respira”), demonstrating how collaboration between citizens and scientists can address complex challenges in biology and health, even in multidisciplinary projects (Romero, 2017).

1.2. Background of the UFSC Campus Bird Field Guide

Birdwatching is one of the main points of contact between society and the natural world, partly because birds are generally conspicuous and charismatic animals. For lay audiences, birdwatching can serve as an introduction to scientific knowledge and environmental education. Promoting this practice within the community is a science communication strategy that contributes to intellectual property development and serves as a tool for socialization, physical exercise, and personal gratification. The Trindade campus of UFSC is highly suitable for this practice due to its diverse environments (forested, shrubby, wetland areas) that attract a significant variety of

species. Socially, the campus also functions as an urban park, a green space frequented daily by thousands of people not only for work and study but also for leisure.

In 2022, a university outreach project was implemented to create a field guide to the campus birds. A field guide is an important species identification tool and also serves as a historical document about local species composition. It traditionally includes occurrence and distribution data, habitat, diet, size, photographs, illustrations, and additional information such as natural history, abundance, migration and seasonality, breeding behaviors, morphology, vocal repertoire descriptions, biological invasion status, and cultural influences (Corbo et al., 2013; Farias et al., 2015; Höfling & Camargo, 1993; Marques et al., 2005; Parrini, 2015; Sick, 1997).

The project prioritized the collective and collaborative process of developing this tool over the final product itself. The social nature of knowledge construction was emphasized throughout all stages, mobilizing professors, students, technical-administrative staff, and various community members interested in birdwatching and wildlife photography.

Originally conceived as a digital book (e-book), the field guide was adapted to a new format, gaining additional functions by integrating with the iNaturalist platform. This adaptation broadened its scope, contributing not only to promoting birdwatching but also to the project's overall goals.

1.3. The iNaturalist Platform

iNaturalist is a widely used Citizen Science platform for recording and sharing biodiversity observations. Since its creation in 2008 at the University of California, Berkeley — and currently in collaboration with the California Academy of Sciences and the National Geographic Society — the platform has facilitated the collection of data on plant, animal, and other organism species, allowing citizens from different parts of the world to contribute directly to scientific projects (Lohan, 2024).

iNaturalist enables users to capture images of organisms in natural and urban environments and submit them for identification, which is carried out both by other community members and by an artificial intelligence system that suggests possible species. This collective process allows the generated data to be used in various biodiversity studies, such as monitoring species distribution or identifying invasive exotic species.

The platform stands out as an important tool for Citizen Science projects, mainly due to its ability to aggregate a large volume of georeferenced observational data. These data, collected by a broad network of participants in different locations and time periods, provide a rich and diverse basis that can be used in academic studies, conservation projects, and public policies aimed at environmental preservation. Moreover, iNaturalist allows for the monitoring of specific projects, offering valuable infrastructure for organizing and tracking data collection initiatives.

Unlike purely academic tools, iNaturalist enables broader and more accessible participation, being used by both researchers and citizens interested in contributing to science. This integration between science and society, facilitated by the use of platforms like this, strengthens engagement in conservation projects and allows for

more comprehensive and diverse data collection, providing access to important research data and encouraging collaboration among different audiences for the protection of biodiversity.

1.4. Objectives

The main objective of this article is to report and analyze the implementation of a Citizen Science project aimed at creating a bird guide for the UFSC campus using the iNaturalist platform. The project seeks not only to develop a reference resource on the local avifauna but also to encourage the active participation of the academic community and the general public in surveying and recording species. Specifically, this article aims to:

- a) Describe the methodology used for data collection and integration of community contributions in the development of the bird guide;
- b) Assess the impact of citizen participation in expanding knowledge about local biodiversity;
- c) Discuss the challenges and opportunities offered by using digital platforms, such as iNaturalist, to engage the community in birdwatching activities;
- d) Explore the implications of this type of initiative for environmental education and raising awareness about biodiversity conservation.

Thus, this study seeks to highlight the transformative potential of Citizen Science in the production of scientific knowledge, emphasizing its collaborative and inclusive nature.

2. Method

2.1. Data Collection

The first stage of the UFSC Campus Bird Field Guide consisted of an avifauna survey conducted by the faculty member responsible for the university outreach project and by students from the Biological Sciences program at UFSC, in collaboration with participants from the wider community, through periodic field trips on the university campus. Participation was open to all interested individuals, without any selection process for volunteers. The field trips, popularly known as «passarinhas» (*birdwalks*), were publicized via email, social media, the university newspaper (Notícias da UFSC, 2023), and booths at science outreach fairs held on campus and other locations on the island, such as the local botanical garden, urban parks, and research and conservation centers open to the public.

Primary data collection methods included transects, route counts, listening points, MacKinnon lists, and lists mediated by the eBird app (eBird, 2025; Ribon, 2010). The systematized list of bird species on the UFSC Trindade campus was compiled from first-hand observations during the field trips, secondary data from academic works on the campus's avifauna, and records from Citizen Science platforms such as WikiAves, eBird, and iNaturalist (Bolduan, 2021; eBird, 2025; Hassemer, 2010; Naka & Rodrigues, 2000; Olsen, 2016; Voitina, 2017; Villanueva & Silva, 1996; WikiAves, 2025). Occasional observations from independent sources were also considered. At the time of

submission of this article, the official list of bird species occurring on the UFSC Trindade campus comprises 153 species.

2.2. Call for Photo Submissions

The project's second stage involved a call for the submission of photographs of the listed species. This stage was widely publicized on social media and around campus, encouraging the community to photograph birds in their daily routines. About 40 photographers, both amateur and professional, contributed images of the species recorded on campus, granting publishing rights for the project.

After the submissions, the LABOAC academic team conducted a review, curation, and editing of the images. This process was coordinated by a university extension scholar to ensure the selected images met certain aesthetic criteria. Image editing, when necessary, was done using the Lightroom application¹. However, these aesthetic criteria were made flexible to encourage the participation of amateur photographers and community members who may not have professional resources or skills. The team made an effort to ensure that every or nearly every contributing photographer had at least one of their submissions included in the publication.

2.3. Development of the Digital Document (e-book)

The third stage focused on producing the digital document (e-book), involving the curation and editing of images, literature review, writing, and text revision, all carried out collaboratively by the LABOAC academic team. Illustrations and design were developed in partnership with local artists. At the time of this article's submission, this stage is in its final review.

2.4. Inclusion in a Digital Repository

In parallel with the work of LABOAC at UFSC, a partnership was established with CienLab at UDESC, aiming to introduce the UFSC Campus Bird Field Guide into a digital repository. The main goal of this stage was to publish the systematized list of species occurring on the UFSC campus on a citizen science platform open to the public, where information about the species and future observation records made by app users would be centralized through the "Projects" section.

This phase began with a comparative analysis of digital platforms dedicated to fauna cataloguing, with an emphasis on those specializing in birds or focused on general biology. The objective was to identify the most suitable tool for developing an accessible and functional digital guide. Criteria such as usability, customization capabilities, integration with external data, and the availability of essential features — such as draft creation and collaborative information curation — were considered.

Although other platforms were evaluated, iNaturalist was chosen because it is an established tool in the field of Citizen Science, with an infrastructure geared towards collaborative species cataloguing and broad adoption by academic communities. Even though it does not offer a native draft feature — initially considered essential for quality control of records — iNaturalist proved to be the option most compatible with the project's requirements, especially due to its accessibility, user-friendly interface, and

¹ <https://www.adobe.com/es/products/photoshop-lightroom.html>

ease of maintenance by biology students and researchers without the need for advanced programming or design skills.

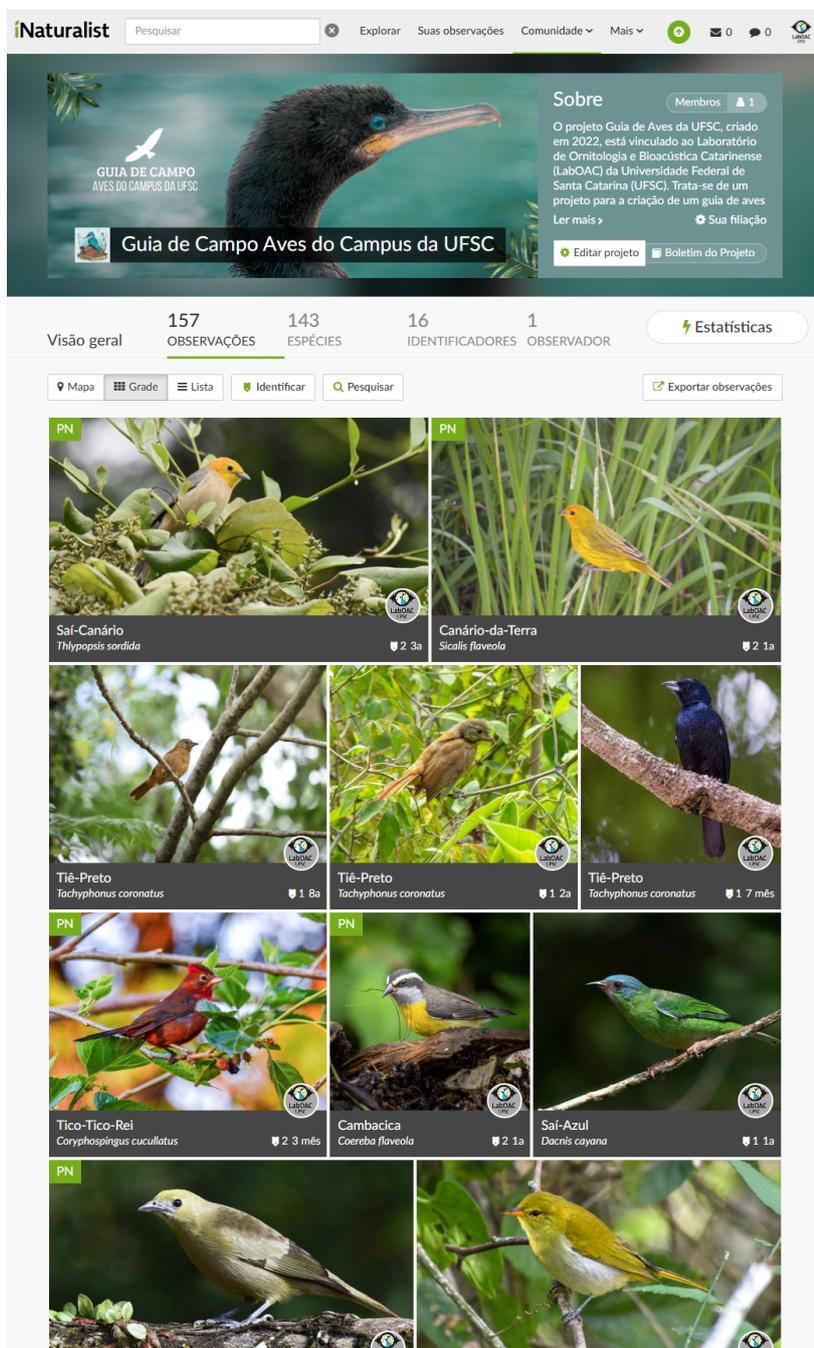


Figure 1. UFSC Campus Bird Field Guide Project on the iNaturalist platform

Once the platform was chosen, an in-depth study of its features was carried out to understand its limits and possibilities in terms of customization and interoperability with external data. The absence of layout customization options was recognized as a limitation but was considered secondary given the robustness of its cataloging and collaborative engagement functionalities.

Coordination with the UFSC Campus Bird Field Guide project team was maintained to align objectives, goals, and deadlines for the development of the repository. At this point, the inclusion of species vocalizations in the digital repository was defined, incorporating a new element into the project to help app users perform taxonomic identifications based on vocalization references (which is especially relevant when it is not possible to visualize or photograph the species in question). To this end, the Xeno-canto platform (Xeno-canto, 2025), specialized in providing recordings of bird vocalizations from around the world, was adopted.

The data entry process was based on a technical spreadsheet developed from the material provided by LABOAC, which contained detailed information about the bird species recorded on the University campus. The new spreadsheet was adapted to meet iNaturalist's requirements, being structured with specific fields such as: order, family, internal identification number, scientific name of the species, presence of photographic records, image review status, direct links to visual records and vocalizations on Xeno-canto, and a field for notes.

The data compilation followed a rigorous process of individual verification for each species. Vocalizations were selected based on the geographical proximity of the recording to the birds' occurrence on campus, ensuring greater ecological representativeness. The spreadsheet, besides functioning as an intermediate repository, served as a substitute for the platform's draft function, allowing for meticulous review of the information before official publication.

The literature review began in September 2024, with searches conducted in five databases: Scielo (B1), LaReferencia (B2), Redalyc (B3), Amelyca (B4), and OpenAlex (B5). The search expression "Ciência cidadã AND Ciência aberta" ("Citizen Science AND Open Science") was used, applying filters to select only open-access articles in Portuguese. All references were managed in Zotero², with metadata automatically imported through each database's connector. To facilitate management, an individual folder was created for each source in the reference manager. Additionally, notes were taken on the functionality and filters of each database to optimize future searches.

After the initial import, Zotero's duplicate detection feature was used to identify and remove duplicate records. Next, artificial intelligence was employed to assist in screening the relevance of the articles. For this purpose, a standard prompt was formulated, requesting SciSpace's tool (SciSpace, 2025) to perform a detailed analysis of each article, verifying a) whether it addressed the definition of citizen science and its relationship with open science, b) whether it mentioned projects involving the academic and general community, and c) whether it covered biology-related topics, always requesting that the corresponding excerpts be highlighted in Portuguese. The specific prompt was: "Por favor, analise o conteúdo do artigo na íntegra e verifique se ele apresenta e explica os seguintes temas: O que é ciência cidadã e sua relação com a

² <https://www.zotero.org/>

ciência aberta; se menciona projetos de ciência cidadã com a comunidade acadêmica e geral; e se menciona algum assunto de biologia. Dê a resposta explicando separadamente cada tema, referenciando local em que é apresentado no artigo. Responda em português.”

The AI responses were added as individual notes in each Zotero record, classifying the approach to each theme as significant or superficial. Based on these notes, an auxiliary table was created to guide the final selection of articles, and all exclusions were documented with their respective justifications, ensuring the traceability of the entire process. Initially, the collection resulted in 0 articles for B1, 6 for B2, 92 for B3, 7 for B4, and 147 for B5. After successive refinements and relevance criteria, 10 articles were selected for the theoretical framework that underpins the study on citizen science and the importance of its projects.

The final stage consisted of entering the data into the ‘UFSC Campus Bird Field Guide’ project created on the iNaturalist platform. This process took place between November 7 and 12, 2024, with support from the CienLab team and volunteers. The presence of metadata previously embedded in the photographs — such as date, author, and scientific name of the species — optimized the repository’s data entry, providing greater speed and accuracy to the procedure.

After completion, the content was reviewed by the LABOAC team, which validated the quality and accuracy of the records entered. In a final meeting, the challenges faced during the process were discussed, as well as the solutions found to overcome technical limitations and achieve the project’s established goals.

3. Results

The initial data collection actions, carried out during the field phase through mobilizations involving both the internal and external community, resulted in the systematic gathering of photographic and observational records of the birds identified around the campus. The spontaneous participation of students, staff, and other collaborators stood out as a decisive factor for the success of the initiative, directly supporting the activities led by LABOAC, which was responsible for the regular organization of observation activities and the consolidation of the project’s database. Short courses and birdwatching events open to the general public were held throughout the project to popularize the practice and disseminate the results achieved.

The quality of the contributions was ensured by a continuous process of monitoring and curation, guaranteeing that the images and records complied with established scientific criteria. Based on the analysis of these contributions, it was possible to organize the information into a structured data table containing detailed descriptions of the recorded species. In this process, the collaboration of ornithology specialists was essential, promoting greater accuracy in species identification and ensuring the technical quality of the systematized information.

Based on the validated data, a digital bird guide model was created, containing descriptive texts, illustrations, and selected photographs, with the aim of making the material accessible and attractive to children and young people. This guide was also made available as a digital repository through the iNaturalist platform, where the

project was officially hosted. The platform enabled the inclusion of multimedia resources, such as photographs and links to vocalizations, as well as the collaborative addition of new observations and continuous monitoring of sightings made on campus. The constant updating of this database on the birds recorded on campus can support academic research in ornithology, urban ecology, and biological conservation. The UFSC campus, with its wooded areas amidst the urban fabric, serves as an ecological corridor between fragmented habitats and has potential to be more widely studied because of this ecological function (Chen et al., 2024).

An interesting development was the completion of an undergraduate thesis by a student from the UFSC Design program in partnership with the LABOAC team (Silva, 2025). This project involved the development of a prototype of a dedicated app for birdwatching on the UFSC campus, aimed at a lay audience and serving as an introduction to this practice. In this way, the UFSC Campus Bird Field Guide took on three forms: an electronic document (e-book), a digital repository (iNaturalist), and an original app.

The development of the app was initially proposed by the Design students themselves, who were interested in the applications of design for environmental education. This was a remarkable outcome, especially because the project's methodology involved field trips for bird observation organized by the external community itself, without any proposal or mediation by LABOAC, demonstrating autonomy in decision-making and in conducting the scientific process, as well as the success of promoting the practice on campus (Silva, 2025).

To make the inclusion of the guide on the iNaturalist platform feasible and to ensure proper data management, CienLAB developed a standardized metadata table covering information on species, photographic and audio records, as well as data related to updates to the digital guide. This initiative facilitated interoperability with the repository and contributed to the digital preservation and open sharing of the data, promoting its use in future research.

4. Conclusions

The development of a bird guide for the UFSC campus through a Citizen Science project demonstrated the transformative potential of collective participation in scientific development. Using the iNaturalist platform as the main collaboration tool, the project promoted the engagement of both the academic and external community in data collection, encouraging birdwatching and involvement with local biodiversity.

The initial results indicate greater environmental awareness, stimulating interest in bird conservation and their habitats. In addition to expanding knowledge of local fauna — since the beginning of the project, at least 10 species not previously recorded on campus have been documented — this is the first initiative to systematically gather and organize photographic records from the area, ensuring accurate documentation of many species that had not been previously recorded.

The project provided a hands-on experience in environmental education, where the public became the main actor in the documentation of scientific data. This

collaboration between citizens and researchers strengthens the relationship between science and society while facilitating the democratization of knowledge.

However, challenges such as maintaining data quality, ensuring continued community engagement, and curating the collected information require ongoing attention. The experience reported in this article highlights the importance of offering clear guidance and training to participants through direct, in-person interaction during short courses and field outings, ensuring that contributions meet the scientific criteria outlined in fieldwork protocols.

Some methodological limitations are also acknowledged: it was observed that most of the active and regular contributors to the project have academic backgrounds — even if not in ornithology — and are already part of the university environment. In the future, strategies could be developed to increase participation from citizens with different professional paths and socioeconomic profiles, in order to enhance the process of social inclusion. Strategies could also be created to further value the contributions of citizen scientists outside LABOAC and CienLab in creative and logistical decision-making processes.

In summary, the UFSC Campus Bird Field Guide will not only serve as a valuable resource for identifying local bird species but also exemplifies the positive impact that Citizen Science initiatives can have in building a more informed society engaged in environmental preservation. The success of this project may inspire similar future actions, reinforcing the need for new collaborative platforms between scientists and citizens in the pursuit of biodiversity conservation.

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ARTICLE / ARTÍCULO

Possibilities and challenges of collaborative teaching networks between university and school: a multi-case study

Posibilidades y desafíos de las redes colaborativas docentes entre universidad y escuela: un estudio multicaso

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Abstract: This article presents the main findings of a multi-case study carried out within the framework of a research project on collaborative networks in education, the aim of which is to gain an in-depth understanding of some experiences aimed at generating inclusive, horizontal and transdisciplinary spaces for dialogue, reflection and collaboration in the design and implementation of pedagogical practices from a critical perspective. This networked, dialogical and participatory research enables the transfer of the results beyond the academic sphere and has an impact on the process of progress and improvement of the centres and teachers involved. From a qualitative, comprehensive and participatory methodological approach, we proceed to analyse various educational scenarios which, despite idiosyncratic differences, share an interest in generating pedagogical knowledge in a collaborative and democratic way. From this perspective, three case studies are presented that reflect university-school collaboration through the implementation of different initiatives in learning communities, pedagogical laboratories and rural contexts. The results obtained show that the construction of networks promotes the exchange of knowledge, the strengthening of links between institutions and the possibility of moving towards other educational models that are more democratic, dialogic, inclusive, critical and committed to social change.

Keywords: Case study, Teacher education, School-community relationship, Participation, Open education.

Resumen: El artículo recoge los principales hallazgos de un estudio multicaso llevado a cabo en el marco de un proyecto de investigación sobre redes colaborativas en educación, cuya finalidad es comprender en profundidad algunas experiencias dirigidas a generar espacios inclusivos, horizontales y transdisciplinarios para dialogar, reflexionar y colaborar en el diseño e implementación de prácticas pedagógicas desde una perspectiva crítica. Esta investigación en red, dialógica y participativa, posibilita que la transferencia de los resultados traspase el ámbito académico e incida en el proceso de avance y mejora de los centros y docentes implicados. Desde un enfoque metodológico cualitativo, comprensivo y participativo, se procede al análisis de diversos escenarios educativos que, a pesar de las diferencias idiosincrásicas, comparten el interés por generar conocimiento pedagógico de forma colaborativa y democrática. Desde esta perspectiva, se presentan tres casos de estudio que reflejan la colaboración universidad-escuela mediante la puesta en marcha de diferentes iniciativas en comunidades de aprendizaje, laboratorios pedagógicos y contextos rurales. Los resultados obtenidos ponen de manifiesto que la construcción de redes promueve el intercambio de saberes, el fortalecimiento de vínculos entre instituciones y la posibilidad de transitar hacia otros modelos educativos más democráticos, dialógicos, inclusivos, críticos y comprometidos con el cambio social.

Palabras clave: Estudio de casos, Formación de profesores, Relación escuela-comunidad, Participación, Educación abierta.

1. Introduction

This article is a collective endeavour derived from the "ReDoC: Collaborative networks in education. Critical teaching for an inclusive society (PID2022-138882OB-I00)" Research Project, funded by the Spanish Ministry of Science and Innovation, the aim of which is to analyse, understand and assess some of the collaborative projects and experiences, from a comprehensive approach, undertaken at the Faculties of Education at the universities of Malaga, Granada, Valladolid, Extremadura, Cantabria, Valencia, Jaén and Cádiz.

Working in a networked environment makes it possible to generate and build knowledge through the creation of links, relations and cooperation between different collectives and institutions in civil society. As Sancho-Gil et al. (2022) propose, never has there been so much talk about networks as there is now, which shows an awareness of global connection and the need to acknowledge the participation of different actors in training processes. This is demonstrated in some of the studies that have been carried out to that effect (Aguilar-Mediavilla et al., 2025, Azorín-Abellán, 2021; Santos-Rego et al., 2022; Solvason, Cliffe & Snowden, 2018; Lieberman & Pointer Mace, 2009).

The current social context has individualist, capitalist, and heteropatriarchal values running through it, which are in keeping with a market-driven trend and one in which knowledge is instrumentalised (Garcés, 2013; hooks, 2024; Freire, 1970; Fricker, 2017; Biesta, 2023; Rodríguez-Izquierdo & Lorenzo-Moledo, 2023; Rivas et al., 2022). In order to deal with this reality, it is both necessary and urgent to review the educational tenets that advocate for critical education, to rethink them to discover how other means of knowledge production are being formulated, as well as other links that move away from the academic hierarchy as the hegemonic model, and other actions that include know-how coming both from the university environment and from the community (Bauman, 2003).

In this sense, in the university sector we must ask ourselves: What spaces for openness and relations with other training operators do we generate? How is knowledge produced? From where? Which people take part in the knowledge generation processes? What knowledge is certified as valid?

All these questions lead us to delve deeper into the possibilities that can be found in collaboration networks as alternative channels to be able to think of another type of education, another type of society (Azorín-Abellán, 2021; Santos-Rego et al., 2022; Leite-Méndez et al., 2018; 2020; Zeichner et al., 2015; Rivas et al., 2022; Hargreaves & O'Connor, 2020). This is the central thread of a project that, despite being woven together from different scenarios and groups, they all share the same purpose: to generate inclusive, horizontal and transdisciplinary spaces in which to encourage dialogue, reflection and collaboration in the design and implementation of pedagogical practices from a critical perspective.

Collaboration, as a political and pedagogical tool, opens the field to explore and go deeper in the search for alternative paths for education to follow. Such paths or channels weave together skills, knowledge and experiences that challenge all the actors involved: university teachers and students, school teachers and students, and the community as a whole. The construction of a third space (Zeichner, 2010) for

meeting, learning, exchange and dialogue is an integral part of a defence of open, inclusive education that takes from all available skills and contributes to breaking down the barriers that prevent or hinder the social transformation of the contexts in which it intervenes (Lieberman & Pointer Mace, 2009; Parrilla et al., 2017).

The purpose of this paper is to demonstrate that egalitarian dialogue, horizontal accompaniment, participatory research, joint production of skills and the creation of new learning spaces generate open training proposals that are critical, inclusive and transformative (Ainscow, 2016; Rivas-Flores et al., 2015; Coburn & Stein, 2010).

2. Method

The research study has taken a qualitative, comprehensive and participatory methodological approach that takes shape in the design of a multi-case study (Stake, 2005; Simons, 2009) that enables us to reflect, and acquire a deeper understanding of the processes that revolve around the networks analysed from an interpretative perspective.

The purpose of the study is to find out more about some of the university-school collaboration initiatives and projects that have arisen in different scenarios, in order to generate lines of reflection that help to identify the strengths and challenges entailed in working as part of a network. Consequently, the ideal option for the purpose in question is considered to be the ethnographic case study, as it allows for an objective analysis of a particular project or programme "endeavouring to understand the case in its sociocultural context" (Simons, 2009, p. 44). The research questions¹ that act as an axis of the investigative process are as follows:

RQ01. Why, and for what purpose, do these collaborative networks arise?

RQ02. What elements foster the development of these collaborative network spaces?

RQ03. What benefits/strengths does participation in these networks provide?

RQ04. What are the difficulties/limitations that these networks face?

Exploration is not imposed by external institutions or entities, but rather it arises from the group's own training needs and an interest in systematising and better understanding what is happening in the different educational contexts in which the members play an active role. This paradigmatic approach provides an opportunity to break away from the traditional structural division between research and practice (Álvarez-Álvarez, 2015; Burkhardt & Schoenfeld, 2003), the natural consequence of which is the minor importance that research coming from universities has for schools (Feuer, Towne & Shavelson, 2002). By contrast, this way of approaching an in-depth study of a specific social and educational reality enables us to engage the people involved in every stage of the process (Gray & Campbell-Evans, 2002), acknowledging their status as peers in the work team, and breaking down the hierarchical relations

¹ The process of generating the research questions was carried out collaboratively by the research group at a seminar open to the scientific community, in keeping with our commitment to open science, and where the ontological, epistemological, methodological and ethical perspectives of the research project were discussed. A summary of this seminar can be found at <https://reunid.eu/2025/01/07/pensando-la-investigacion-educativa-desde-la-construccion-colectiva-de-sentidos-bitacora-de-viaje/>

between who is researching and who is the subject of the study, which makes it possible to achieve a joint construction of meanings (Freire, 1970).

The information was essentially collected by means of participant observation (in classes, at events, workshops, etc.), taking notes in the corresponding field logs, carrying out open and semi-structured interviews, and through organising focus groups, considering each one of the selected cases intentionally, as communities in which there is a dialogical openness that allows us to advance in the collective and horizontal construction of knowledge (Freire, 1970; Wenger, 2001; Phillips et al., 2013; Corona-Berkin, 2019).

In this regard, we defend the feasibility of thoroughly analysing the operating dynamics of a given network, while helping to weave that network with the actions that each person implements from their respective scope of action, as research dealing with collaborative networks for critical and inclusive teaching must directly challenge those who carry out that work, and it should be taken as a valuable opportunity for professional development.

For the analysis, we have systematised the collected data in each case through the assorted tools, to then use the questions to gradually define the different categories of analysis that are shown in Figure 1, and which have been specified thanks to the metacognitive process of the research team in a series of regular meetings.

Needs linked to the creation of networks	To articulate University/School connection mechanisms To improve teacher training To transform educational research To recognise the relevance of educational contexts
Enabling elements	Horizontal and ethical relationship of care Mutual learning predisposition Common objectives Egalitarian dialogue Distributed leadership Active listening and mutual understanding
Benefits/strengths	Reciprocal learning and shared knowledge construction Sense of belonging Critical reflection of the teaching practice. Teacher-researcher role Reconstruction of professional identity Interdisciplinarity and collaboration
Difficulties/limitations	Lack of institutional recognition Work overload and lack of time Tension between academic logic and school logic Personal sacrifices

Figure 1. Category system.

Ethical considerations occupied a central place in the research design. Informed consent was obtained from the teachers and students, and their participation was voluntary, noting that they could withdraw at any time. Anonymity and confidentiality were guaranteed, assigning codes and pseudonyms to the participants and institutions, and storing all data securely, in keeping with data protection regulations. The results and discussion were presented from a respectful, dialogical and reflexive position, and said presentation was negotiated with the participants in the study.

To conclude this section, we offer a brief description of the cases analysed for the purposes of this paper.

2.1. Case I: RedComunidades [communities network]. Building training networks for collaborative work with education centres.

To see how links were created with the education centres with which there is current collaboration, we would need to go back more than 15 years, when the related work began in subjects from different degree programmes at the Faculty of Education Sciences at the University of Malaga. The intended aim was for students to be able to build their professional identities and feel part of an education community from the first year of their teacher training (Fernández-Torres et al., 2019; Mastache et al., 2023; Márquez et al., 2020; Wenger, 2001).

This initiative is based on the conviction that democratic projects must be put into practice that are aimed at promoting investigation and transformation processes from the responsibility and joint commitment of all the institutions involved in teachers' initial training (Barnes, 2017; Cochran-Smith & Lytle, 2003; Rivas et al., 2016). The objective with this is to foster the consolidation of a network with centres at different levels of education, recognised as Learning Communities².

In recent years, ties have been strengthened between the participating institutions, establishing times and spaces for growth through a dialogical relationship (Leite-Méndez & Velazco-Fano, 2022; Márquez-García et al., 2022; Rodríguez-Gallego & Ordóñez-Sierra, 2015; Procie et al., 2025).

To achieve a deeper understanding of life in those centres, two of them were selected, which, due to their characteristics, offered the possibility of designing a collaborative research project.

The first centre in question is a school located in the city centre, with one class per academic year. The population profile is very diverse, with some families living in an area considered more deprived (economically, socially and culturally) with a significant number of immigrant students, and others coming from a residential area, with a higher economic and sociocultural level.

One of the identifying features of the centre is its cultural diversity, as a large number of students come from abroad, making them a majority presence in each classroom. Apart from the challenges this poses, it has become an opportunity to grow on the basis of their differences and to discover other customs, cultures, beliefs, etc.

The second school is located in a rural area in the mountains. This centre takes in students from Infants up to the second year of Compulsory Secondary Education (ESO). Much like other rural schools, it endeavours to survive in a context where a lack of students is a constant concern, brought on by the exodus of families moving to other areas with better communication, due to economic or educational needs. This situation can generate a reduction in the teaching staff and uncertainty in each school year.

² <https://www.juntadeandalucia.es/educacion/portals/web/escuela-familias/participacion/experiencias/comunidades-de-aprendizaje>

Over the last few years, areas have been prepared and equipped for carrying out a range of activities, based on pedagogical and fundamental perspectives, and sustained through the dialogical establishment of links between the education community and the rest of the people who live in that town.

2.2. Case II: PedaLAB pedagogical laboratory. Research as a meeting space between schools and universities.

The PedaLAB pedagogical laboratory arose out of an initiative by the ICUFOP Research Group at the University of Granada. It began in January 2021 under the institutional momentum of the ERDF Operational Programme in Andalusia 2014-2020. The funding of the project "The pedagogical laboratory as a driving force for inclusion of the education community in the ESO stage: Assessment and implementation of emerging and disruptive practices (B-SEJ-374-UGR18)" made it possible to launch this laboratory in its first two years of existence, which has continued its activity thanks to an innovation project funded by the Quality, Teaching Innovation and Foresight Unit at the University of Granada and a research project that has been approved by the Regional Government of Andalusia Department of Education Development and Vocational Training. Thanks to the recognition of their work in the process of building bridges between schools and universities, they now form part of the structure of the Area of Education, Mediation and Territorial Outreach, which comes under the Vice-chancellor's office for Outreach, Heritage and Institutional Relations at this university.

The lab was created with the purpose of establishing collaboration networks between schools and universities, generating a meeting space where professionals from both institutions could discuss and, following this exchange, initiate processes of training, research and transfer in education. The inspiration for their creation came from citizen labs, which have emerged in the last decade as a tool to connect people from wide-ranging fields of knowledge and to design projects that can transform different social environments (Pascale & Resina, 2020).

The initial phase of their lab activity entailed a call across diverse media to generate a virtual encounter, in which teachers of formal and informal education, from different stages and areas, tackled the challenges and needs of their work environments. In this "virtual café", they discussed the importance of research as a process through which to improve the teaching practice, art as educational mediation, and the need to create exchange networks. These topics were included in the lab's road map. Two types of activities were organised: a) seminars of experiences, where teaching professionals shared the practices being developed at their centres, thus promoting the requested exchange network; and b) conferences and talks with experts who addressed the specific training needs or wishes put forward by the teachers.

It was precisely during one of these encounters that a common interest emerged regarding the incorporation of students' musical preferences in the classroom, and the contradictions that were raised with regard to the use of this music which, in many cases, was not deemed appropriate for a school environment. The need to understand these processes, and to do so from a critical educational position, fostered the initiative to carry out a collaborative research project. In this way, the figure of the teacher-researcher (Stenhouse, 1981) was placed in the centre as the person responsible for highlighting the research component that exists naturally in the

daily life of the classroom, and to take it to a more advanced level through a process of systematisation.

This collaborative research began with a pilot project that enabled them to identify the conceptual framework, the questions, methodology, information collection and analysis tools that would serve to build a research project with the title "Musical identities and democratic values in the classroom: the educational implications of using students' musical preferences (PIV-021/22)", which was endorsed by the Regional Government of Andalusia, and which has been the central axis of the Lab's activity. The transfer of activity in this network has come about through their web page, their YouTube channel, social media, and participation in different academic events and teacher training exercises, the preparation of a text (Ocaña-Fernández, 2023) and by holding the 1st and 2nd PedaLAB Encounter in face-to-face format.

In this lab, there is no first-class knowledge or skills, no undisputed actors, no decisive roles, as this common good that is education requires an assembly of heterogeneities (Lafuente, 2022). Research has become the mortar that has made it possible to build that bridge so that schools and universities can come together, and from a dialectic experience of understanding and collective action, they can find a way to imagine scenarios in which it is worth living (Garcés, 2020).

2.3. Case III: Red EducoRural [rural education network]. Universities and the rural environment

The seed of the Red EducoRural was planted after the 1st International Congress on Rural Education, which was held in Cortes de la Frontera in April 2024. One of the most talked about and recurring topics at this event was the need to approach the reality of the Centros Públicos Rurales [clusters of rural schools forming one education centre] (CPR for their initials in Spanish) at the different degrees of education, as there are currently no university subjects that deal specifically with the unique features that define these particular education contexts. To respond to this question, a group of professionals from different institutions decided to work together to implement specific actions that could highlight rural schools, and to link knowledge that has traditionally been considered as academic with those experiential skills that come from direct contact with the actual cases in the different territories. From this perspective, the collective has launched some interesting initiatives, such as their participation in academic and dissemination events, writing articles for publication in scientific journals, and organising a blended 25-hour course on "Methodological strategies for socio-educational attention in rural contexts", which marked a definitive step in consolidating the network and endeavouring to ensure that collaboration in the training processes is systematic, continuous and long-lasting, underlining the learning potential of the synergy for all parties involved.

3. Results

Following the research process that has been shared in the methodology section, we now present the results of the field work carried out in each case. The evidence provided stems from the voices³ and reflections⁴ of the participants, and it responds to

³ Interviews with teachers (ED), seminars (S) and focus groups (GF).

⁴ Class forums (FC) and university students' learning stories (RA).

each one of the questions that were raised at the start, when designing the research project.

3.1. RQ01. Why, and for what purpose. do these collaborative networks arise?

Even though there is a different reason for the creation of each specific case, the three cases presented share the need to minimise the existing gap between universities and schools. This distance is common knowledge in the university environment, and that is why collaborative projects are trying to generate meeting spaces aimed at a joint construction of knowledge, with the participation of all the sectors involved: students undergoing training, university teaching staff and teachers at education centres and schools, as well as entities and associations that collaborate with both universities and schools.

In the first case, collaboration with the centres is initiated following the university teaching staff's express intention to ensure that students can build their professional identities by associating themselves with school contexts, for the purposes of creating situated, open learning with a deep commitment to the population as a whole. In this sense, teachers appreciate the students' participation in the classroom and they share perceptions regarding how they relate, what they do, why and for what purpose. Likewise, they try to ensure that there is sufficient reflection and debate about which pedagogical skills should be strengthened and what the main obstacles that make the teaching job difficult are.

The students are placed at the centre of the training process. Both in the class forums and in the accounts of their learning, the students claim that

«it is a unique experience, being able to participate in the centres as equals» (FC E1) and that «they feel like they are a part of everyday life at the centres» (FC E2).

They also recognise that

«we have a lot to learn and we realise that there are a lot of gaps in the training we have received» (RA E3).

In turn, there are those who have discovered their passion:

«teaching is my life» (RA E6), «this is what I want to do in the future» (RA E8);

and those who have been surprised to find out

«what they are like, how they speak, and the knowledge the children have» (FC E7),

fostering a discussion about the ideas of childhood that prevail in the hegemonic discourse in initial teacher training.

In the second case, the fact that the impact of the research carried out at universities is minimal, or practically zero, in school contexts, gave rise to the possibility of setting up a pedagogical lab to enable different skillsets to come together and research projects to be developed from schools and with schools. The purpose of this is to foster an educational transformation based on scientific evidence that comes from

an analysis of the experience itself, and not just from the analysis carried out by academia, leading to an emancipation of the teaching staff. Below are some of the fragments taken from a dialogue at one of the lab seminars:

«That's a university thing»; «research is for those who know and have time on their hands»; «universities come to schools just to collect data and then they just publish, publish, publish»; «research deals with questionnaires and data that serve no purpose at all in schools» (S 1).

In the third case, the reason behind the creation of this network was the conviction that the urban-centred paradigm that permeates today's ever-changing, fast-paced modern life, has led to the teaching work in rural schools being swallowed up, work which has already been affected by a series of circumstances that need to be known, because what is not known, is not understood, and what is not understood, is not valued. To this effect, it is considered that the best way to introduce the characteristics that define teaching in single and multi-grade classes in faculties of education is by establishing contact with teachers in rural schools, who are willing to have their teaching work highlighted and to share their experiential skills with university students. One of the teachers interviewed says as much, when they claim that these kinds of actions are relevant

«because they contribute to expanding the students' concept of inclusion to accommodate human and contextual diversity, as not all education centres have the same characteristics and needs» (ED 1).

3.2. RQ02. What elements foster the development of these collaborative network spaces?

In these processes, where education actors and institutions undertake and initiate the joint construction of common spaces, we recognise some elements that appear to be essential for ensuring they are made into a place for everyone. In all three cases, we can stress that the participants were all predisposed towards mutual learning, arising from a horizontal relationship based on the ethics of care, and which sets the common objectives at the education centre. This is how it is expressed and acknowledged by those participating in the network, where the direction of said network is a constant feature from the outset:

«The network is gradually built from the contributions of each and every member, we are all here because we want to, so I think that nothing is forced upon us here, and if we are suggested anything that we are not convinced about, then we talk about it. So I believe that the strength of this network is that it enables us to be who we are, we are valued for who we are, and we can be however we want to be» (S 2)

Egalitarian dialogue stands out as a driving force both for learning and for professional development. Everything is possible through dialogue, but it has to be emphasised from an early age. We must also ask ourselves why today's society does not promote a mutual exchange of skills.. In the interviews, the management teams highlight the power of pedagogical projects and the fact that everyone involved participates on an equal basis in the proposed actions.

«That gives us assurance» (ED 2) y «we all learn» (ED 3).

So, several features stand out, such as: dialogue of knowledge, active listening, mutual understanding, distributed leadership, and horizontal accompaniment. In this regard, the aforementioned aspects coincide with the principles of collaborative professionalism that Hargreaves and O'Connor (2020) discuss in a research project that explores different education contexts in different countries.

3.3. RQ03. What benefits/strengths does participation in these networks provide?

In all cases, an emphasis is placed on the possibility of reciprocal learning and the generation of shared knowledge that participation in a network provides. This learning takes all skills into account, it gives them their space and recognises their worth. The teaching staff are amazed at what the children say through the dialogue that is generated in the different talks and gatherings.

«They bring up subjects and issues that I would never have thought they could mention» (ED 4).

These ideas are shared and produce another type of knowledge through experience, other resonances in other groups of teachers and students:

«I was able to see how they considered me when making decisions, and that I could suggest activities to the group that I was interested in. I think that the coordinator does a good job to ensure each participant feels part of the group and her leadership is marked by her ability to unite the group and all our different profiles» (GF 3)

There is a break from the vertical training structure, giving way to the design of new horizontal training strategies, where everyone involved plays a part.

«Taking our daily worries and difficulties as a starting point, we gradually think as a whole, as a group; ideas and forms of action are put forward, and this generates bonds and learning» (ED 5).

By establishing an approach to schools from a different position that enables other ties to be created with the education community, university teaching staff can better understand the schools' reality:

«With the perspective of this year of work, and everything it has given me as a teacher and as a researcher, I don't have the slightest doubt that it is worth rejecting that other path that is more connected with the productive logics of academic research. As a teacher, I now go into the classroom without the imposter syndrome that has always haunted me. Now I can tell my students the reality of today's classrooms of which I have first-hand experience, thanks to this research project» (GF 2)

The reconstruction of the teaching identity is also recognised, which is gradually generating an emancipatory process through a *Freirian* approach, as well as a process of interdisciplinary understanding of the pedagogical practice.

«Working with others is enlightening and rewarding, it gives you confidence and security. Moreover, what one person can't think of, another one can, or the proposals dealt with collectively have a greater impact on the work and on that emotional dimension of feeling a part of something» (ED 2)

In this cooperative work, the margins between the teacher and researcher roles are blurred, and the teaching staff begin to question their pedagogical action with the aim of becoming aware of the possibilities of progress, through critical and grounded reflection:

«The lab has given me the chance to systematically reflect on my teaching work instead of having the feeling that my achievements over the years have just been a lucky break or by having 'common sense'» (GF 3)

Egalitarian recognition and participation produces a sense of community and belonging to the group, something which drives and embraces all those who form a part of it:

«One of the secrets to making this work is that we speak the same language, it is good to find a place where people understand what you say and why you are saying it. At my education centre, I feel that I am swimming against the tide, and since I have been at the lab, I am more motivated and with more enthusiasm to do different things at my school» (S 1)

3.4. RQ04. What are the difficulties/limitations that these networks face?

However, the creation of collaborative networks is not without its challenges. We cannot ignore the complexity of joint work, as well as the implications that this entails both in the professional and personal spheres for those involved. Both the school teaching staff and the university teaching staff face a series of limitations that can have a bearing on the work undertaken by the different established networks.

Among the main difficulties in all three cases, we can specifically point out the lack of recognition by the institution. The people who participate in these networks do so on a voluntary basis and out of a concern to improve both the education processes and their own teaching work. Nevertheless, they do not feel that their efforts are valued in the institutional environment, nor do they feel they are given any recognition, as does occur in other cases of continuous training:

«For me, personally, it's nice to know that I am spending time on something that is going to have a positive impact on my classes, although it would help if we could get some kind of certificate or if it would count towards our six-year service period» (GF 3).

Along that same line, they remark on the lack of time and the amount of effort required to include these networks in the job in parallel to their professional duties, sacrificing their personal time to be able to fulfil the responsibility that they have taken on, and they convey as such in their statements:

«We carry out a lot of actions and activities, but there is very little time for preparing and recording, with a collaborative university-school initiative, you could think and work differently to be able to recover and account for the education centres' work» (ED 6).

Lastly, the people who make up the network recognise the differences in research culture. This research has traditionally focused on "extracting data" from "reporting persons", and translating the results in an academic language that has little or nothing in common with schools' wishes or needs, providing merit only in the direction of those researching. In these cases, the dialogical sense of research studies

must apply a different focus that does not yield in the same way, as the objectives are gradually set as they go along, and the merit is shared with all the people involved:

«Taking part in this research project has entailed certain sacrifices as a university teacher. Carrying out this study requires time and dedication that makes it impossible to do other things that, for me personally, would be more beneficial» (GF 2).

4. Conclusions

Responsible, committed and critical interaction on the part of the members of the networks is key for their consolidation and to ensure they last over time. Mutual trust and commitment are progressively generated through regular working sessions where dialogue takes centre stage in the training process (Hernández-Rivero et al., 2020). This possibility for dialogue in the sense put forward by Freire (1970), hooks (2024) and Corona-Berkin (2019), enables there to be a space for open, egalitarian conversation, where listening is genuine in order to understand, to form relationships, to think about community and to ensure that everyone's interests can be taken into account, and to generate processes of educational transformation.

The diversity of individual experiences and the existence of disagreements at the heart of a heterogeneous group fosters an environment for discussion that is conducive to the construction of ideas (Bennett & Gadlin, 2012). This intersection of subjectivities generates dissent and negotiation around the subjects they are dealing with, which enriches community actions and views (Barnes, 2017).

However, the construction of this dialogic space is no mean feat, as it requires responsible and committed interaction on the part of the people who make up the network. It is therefore necessary to overcome the individuality/collectivity tension so that, once the other person and oneself are recognised as individuals, a community vision can come into play (Bauman, 2003; hooks, 2024).

The promotion of solid social ties and the creation of a space where everyone has a voice and their voices are heard, makes it possible to achieve a dialogic exchange of skills and knowledge. However, this model also faces its own challenges, as a rejection of vertical and centralised forms of organisation can lead to a lack of stable, long-lasting structure. Hence the importance of coordination under distributed leadership that is vigilant to be able to detect and correct any possible inertias that may be conducive to reproducing power relations (Hardt & Negri, 2017).

These networks allow us to rethink the cultures of training, innovation and research that exist both in the university institution and in the school institution. They generate meeting spaces where these cultures are questioned and redefined, searching for new ways of existing, on the basis of approaches that connect with critical pedagogy, feminist discourses and the idea of teacher-researcher. The idea of change and improvement is a recurrent theme in the start and development of networks, which become spaces for connection that need to be supported by the accomplishment of a mission that is clearly aimed at meeting needs and getting results that bring about benefits for the whole group (Garcés et al., 2022).

Working together broadens our views of pedagogical practice through an interdisciplinary understanding that brings different skills (disciplinary, practical and experiential) into play, and which enables an explanation to be put forward from a range of perspectives of one same situation, generating learning that would not be possible using a single analysis carried out by the actors from one side or the other. Hence the importance of making these spaces converge and accepting that the responsibility is shared by the entire education community. The need for teachers in training to experience the inherent reality in schools first hand is therefore understood, and it is important that they share their visions with practicing professionals (Cantón & Tardif, 2018; Madueño & Márquez, 2017).

Within the existing training pathways, the possibility of being and being part of life in schools from the outset is yet another stance that enables both the students in attendance and the schools, as well as the university teaching staff, to design shared research projects to work towards achieving social, institutional and personal transformation (Cortés & Márquez, 2017; Leite et al., 2018, 2020; Rivas et al., 2015).

This other way of carrying out research alerts us to the transformative capacity that including research in the classroom can have as an element for empowerment and emancipation. This emancipation is not determined merely by access to knowledge, but by "the possibility to be on an equal basis in the dispute over who can know what, from which point validity is given to our skills, and what consequences there are of how we live" (Garcés, 2018, p. 27). So, research and pedagogical action converge in a collective process of shared knowledge creation that becomes a common good, and which generates an interdependent relationship between schools and universities that is necessary now more than ever.

Furthermore, it is worth pointing out that time is a key element in the set-up of these networks, it is a slow process that makes it necessary to dissociate from the academic world's productive logics and to slow down and allow ourselves to be amazed by the events that unfold around us (Biesta, 2023). We find ourselves faced with a degree of resistance to bureaucratisation and precariousness that cancels out the chance to develop different processes, and which forces us to make a greater effort, because these "other" paths do not work in fast networks, neither do they adapt to the paces set. On the contrary, they need to take their time and be tolerant to ambiguity, negotiation and empathy (Zafra, 2017).

Cultural and political differences in the work of both institutions pose a challenge to the creation and development of these networks. Differences related to the recognition of certain activities and with discrepancies regarding the culture of research, make it necessary to acknowledge the diverse professional identities and origins, as well as redefining participation, action and investigation concepts (Santos, 2016). Despite being tied to the university institution, these networks are generated from the sidelines, taking into account the voices of those who build them from those sidelines. This circumstance, which entails difficulties related to a lack of recognition, lack of resources or a rejection by certain sectors, becomes a strength that enables other more transgressive ways of doing things to be constructed, ones which are committed to the decentralisation of institutions. Cultural models are changing by implementing another way of building knowledge.

These networks allow thought to be decolonised, in the sense that they break down the hegemonic thinking, taking into account other voices and other skillsets. They promote spaces for dialogue where dissent is considered a value and where difference is allowed.

In these networks, the participants' commitment, honesty and generosity is essential. The relationships that are slowly and steadily forged with these elements give rise to an emotional/personal connection that strengthens the network's foundations and activity, and enables it to develop and expand. In this regard, the key factors of time, space and relationship sustain the networks, but they also become dimensions with dual value: they make change possible and result in new paths, or they block movement, leading to stagnation and neglect.

By way of an epilogue, it is worth highlighting the words of Galeano (2017) from one of the short stories in his famous *The Book of Embraces*: "the world is a heap of people, a sea of tiny flames." (p. 5). To prevent these small, solitary and isolated flames from going out over time, they have to be given oxygen. Following on from this metaphor, working as part of a network provides the oxygen necessary to ensure that those flames, which symbolise teaching actions aimed at developing critical and inclusive thinking, are kept alive. In short, in keeping with the results obtained in the research study, we are able to affirm that the collaboration and active participation of people outside of the strictly academic sphere in the training and research processes is a breath of fresh air that strengthens education. Therefore, we must endeavour to always leave the windows open.

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ARTICLE / ARTIGO

Using Generative Artificial Intelligence and Keyword Analysis to Support the Design of Research Projects in Higher Education

Uso de inteligência artificial generativa e análise de palavras-chave para apoiar o planejamento de projetos de pesquisa no ensino superior

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Abstract: At different levels of higher education, students face challenges in identifying information aligned with their research projects, requiring a balance between specificity and breadth in locating relevant sources. Studies show that metacognitive skills, such as refining keywords and navigating through organized categories, enhance the efficiency and quality of information searches. In light of these challenges, this article investigates the combined use of word co-occurrence analysis and Generative Artificial Intelligence (GenAI) as a strategy to support the definition of research project scopes in higher education. The study employed a qualitative methodology, involving 23 undergraduate and graduate students who completed two questionnaires, interspersed with the delivery of a personalized report. This report was generated based on searches in bibliographic databases, integrated with GenAI analysis, and included keyword suggestions, search strategies, and a glossary. The results indicated that the procedure stimulated reflective processes in the students, with most considering the intervention useful, particularly for refining keyword definitions. It was also evident that the method's effectiveness depends on the clarity of the initial information provided by participants and the maturity level of their projects.

Keywords: Co-word analysis, Generative artificial intelligence, Research scope, Research project, Higher education, Open science.

Resumo: Em diferentes níveis da educação universitária, estudantes enfrentam desafios para identificar informações alinhadas a seus projetos de pesquisa, exigindo equilíbrio entre especificidade e abrangência na identificação de informações relevantes. Estudos mostram que habilidades metacognitivas, como o refinamento de palavras-chave e a navegação por categorias organizadas, favorecem a eficiência e a qualidade das buscas realizadas. Diante dessas dificuldades, este artigo investiga o uso combinado da análise de coocorrência de palavras e da Inteligência Artificial Generativa (IAGen) como estratégia de apoio ao delineamento do escopo de projetos de pesquisa no ensino superior. O estudo adotou uma metodologia qualitativa, envolvendo 23 estudantes de graduação e pós-graduação, que responderam a dois formulários intercalados pela entrega de um relatório personalizado. Esse relatório foi produzido a partir de buscas em bases bibliográficas, integradas à análise com IAGen, e abordou aspectos como sugestões de palavras-chave, estratégias de busca e um glossário. Os resultados indicaram que o procedimento instigou processos reflexivos nos estudantes, sendo que a maioria considerou a intervenção útil, especialmente para refinar a definição de palavras-chave. Também ficou evidente que a eficácia do método depende da clareza das informações iniciais fornecidas pelos participantes e do nível de maturidade dos projetos em desenvolvimento.

Palavras-chave: Análise de coocorrência de palavras, Inteligência artificial generativa, Escopo de pesquisa, Projeto de Pesquisa, Ensino superior, Ciência aberta.

1. Introduction

At different levels of higher education, defining the scope of a research project is an activity in which both undergraduate and graduate students face numerous challenges when searching for and identifying bibliographic information related to their projects. These students must strike a balance between the specificity of their research topics and the openness required to find useful information that aligns with their scientific propositions. Studies indicate that students with stronger skills in refining keywords tend to achieve more successful search results in their tasks (Tu, Shih, & Tsai, 2008). Practices such as location-based hierarchical navigation and the use of social tags are additional examples that can enhance search effectiveness (Liu et al., 2011). These studies are significant as they highlight the importance of keywords in students' learning contexts, even though their findings were based on high school students conducting web searches.

Technological tools for defining the scope of research projects are becoming increasingly critical due to the growing volume and complexity of scientific literature. One such tool, word co-occurrence analysis, identifies terms that frequently appear together, revealing conceptual associations (Callon et al., 1983). This method enables an understanding of semantic relationships and provides a solid foundation for generating keywords and defining research scope (Klarin, 2024). Large Language Models (LLMs), on the other hand, represent a significant advancement, capable of processing, generating, and structuring complex information due to their training on vast textual datasets. In the scientific context, LLMs show potential to broaden analytical perspectives and inspire researchers by suggesting connections with analogous fields (Peres et al., 2023). The combination of these technologies enhances conceptual clarity, deepens understanding, and expands methodological possibilities in contemporary academic research.

In light of this context, this study aims to investigate how the automated evaluation of academic research projects can assist students in understanding the scope of their proposals and in defining keywords that accurately represent their field of study. The increasing volume and complexity of scientific literature demand approaches that support students in active learning experiences. In this scenario, it is essential that they feel empowered to relate concepts, identify patterns, and explore research possibilities in an autonomous and critical manner. Accordingly, this article poses two research questions:

RQ1. Did the keyword analysis, combined with graphical visualization of co-occurrences, contribute to the reformulation of the list and to increased confidence in the selection of keywords?

RQ2. What are students' perceptions of the usefulness of rethinking the set of keywords as a way to refine the scope of research projects?

Together, these questions form an analytical framework to understand how the combination of word co-occurrence analysis and Generative Artificial Intelligence (GenAI) can support students in the iterative refinement of their research projects. These dynamics can be examined in light of the Theory of Information Seeking and Use Behavior, which describes how users interact with information systems, select, and refine search terms to find relevant content (Wilson, 1999).

In this process, the formulation and iterative adjustment of queries play an essential role in knowledge construction, enabling students to expand or narrow the scope of their investigation based on new insights and semantic relationships. The method presented here evaluates whether the integration of GenAI with data extracted from the scientific literature can, in fact, serve as an educational resource for defining the scope of research. The aim is thus to contribute to both the quality of academic work and the autonomy of the research process.

Related works that support research project development include the dissertations of Simone de Oliveira (2017) and Ederson Bastiani (2022), although these do not specifically focus on keyword analysis.

The following sections present the theoretical foundations of scope definition, word co-occurrence analysis, and GenAI, which are essential to understanding the research objectives.

1.1. Defining the Scope of a Research Project

Academic research is essential to higher education, shaping skilled professionals and contributing to innovation, knowledge advancement, and social development (Schwartzman, 2022). A structured definition of research scope, within the context of information behavior, refers to the “systematic delimitation of the conceptual, methodological, and practical boundaries of an investigation, establishing what will be included and excluded from the study” (Wilson, 1999, pp. 256–257). Kuhlthau (2004) adds that the scope evolves during the information search process, particularly during the formulation stage, which is often marked by initial feelings of uncertainty and confusion that gradually give way to greater confidence as information is assimilated.

Proper definition of scope and the configuration of a research project are crucial, especially at the graduate level. Advisors play a key role in helping students shape and refine their projects to ensure they are feasible and relevant; however, exploring methodological approaches can be beneficial in finding an optimal balance (Cooksey & McDonald, 2019). This process offers students opportunities to define the boundaries and extent of their studies (Mbuagbaw et al., 2020; Peters et al., 2020), identify relevant variables to be investigated, or map out concepts within a knowledge domain (Pessini, Yamane, & Siman, 2022), and to provide a framework for decision-making (Tricco et al., 2018).

Whether exploratory or systematic, the process of preparing literature reviews requires the construction of search strategies in databases to retrieve the best information to help formulate the project scope. Methodological strategies described in the literature aim to facilitate the development of search models for reviews (Delaney & Tamás, 2017; Bramer et al., 2018; Grames et al., 2019), but these approaches

are generally targeted at professional audiences familiar with systematic review protocols and who typically possess greater fluency in scientific vocabulary. This thematic and semantic structuring is essential for developing search strategies aligned with the research objectives. However, due to the increasing complexity of scientific data, specialized tools have become important to support students in the early stages of research development.

Defining the research scope involves setting goals and boundaries that guide the investigation. According to Wilson (1981), information needs arise from personal, social, and environmental contexts, and may be physiological, cognitive, or affective, all of which drive the information-seeking process. Barriers such as psychological, demographic, social, or environmental factors can interfere with this process. For instance, the perception of self-efficacy influences the motivation to seek information, while limited access to resources may restrict it. Understanding students' context is essential to support their searches. Dervin (1998) emphasizes that users face knowledge gaps and use information to "construct meaning." Ellis's model (1989) describes strategies such as starting, chaining, browsing, differentiating, monitoring, and extracting as ways to locate and filter relevant information.

When defining research scope, it is crucial to consider intervening variables, information needs, knowledge gaps, and use strategies. Word co-occurrence analysis and Generative AI can assist in mapping the focus of study. The following sections explore these approaches and their potential benefits.

1.2. Keyword Co-occurrence

Keywords provided by authors are essential elements in scientific articles, widely used to optimize text retrieval in bibliographic databases. Typically composed of three to five terms, they may appear literally or in varied forms within the text, representing concepts that go beyond the direct content of the work (Pęzik et al., 2023).

Keyword co-occurrence, a key concept in bibliometrics, refers to the frequency with which two or more terms appear together within a textual corpus, such as scientific articles (Zupic & Cater, 2015). This technique enables the mapping of semantic relationships and the identification of conceptual patterns, offering a comprehensive view of the thematic structures within a field (Callon et al., 1983). In bibliometrics, it has been widely used to construct scientific maps and thematic hierarchies, aiding in the understanding of connections between research areas and in tracking emerging trends (He, 1999; Zawacki-Richter & Latchem, 2022).

Beyond thematic mapping, co-occurrence analysis plays a central role in identifying and refining keywords, which are crucial for information search and retrieval (Zupic & Cater, 2015). Its application in research projects contributes to defining scopes with greater clarity and alignment with the current scientific discourse. Recently, the integration of Large Language Models (LLMs), applied in language generation tasks (a form of Generative AI), has enhanced this technique by detecting complex semantic relationships with high precision (Klarin, 2024). This synergy represents a promising approach for students and researchers in improving search strategies and scope definition.

1.3. Generative AI for Information Extraction

Large Language Models (LLMs) have become powerful tools for Natural Language Processing (NLP) tasks such as Information Extraction (IE) and keyword selection (Han et al., 2024). Trained on vast datasets, they understand and generate language in a way that closely resembles human communication and have been widely adopted in academic settings (Chang et al., 2024). Their main advantage lies in handling ambiguous and complex requirements across various domains (Lei et al., 2024). When used to create new texts, summaries, responses, or suggestions, they fall under the category of Generative AI.

Despite their strong performance in tasks without specific training (zero-shot or few-shot), LLMs tend to underperform in traditional IE when compared to fine-tuned models such as those based on BERT (Bidirectional Encoder Representations from Transformers). However, they stand out in Open Information Extraction (OpenIE), as they allow the identification of entities and relationships without predefined categories, making them adaptable to different contexts (Xu et al., 2024).

In the e-commerce domain, Maragheh et al. (2023) proposed LLM-TAKE, a model that improves keyword selection by filtering out uninformative or hallucinated terms, outperforming benchmarks on real-world data. Limitations include dependency on reference data, high computational cost, and the risk of hallucination.

For scientific contexts, Dagdelen et al. (2024) developed a method for Named Entity and Relation Recognition and Extraction (NERRE), capable of generating outputs in both natural language and JSON format. It stands out for its usability and integrated entity normalization but struggles with formatting issues and the generation of non-existent information.

Lee et al. (2023) addressed the lack of keywords in AI conference papers by proposing the use of Meta's Galactica model for automatic keyword generation. Based on similarity metrics, the study showed that 42.7% of the generated keywords matched those defined by the authors, outperforming previous approaches. GPT-based models (Generative Pre-trained Transformer) and RAG (Retrieval-Augmented Generation) have also demonstrated proficiency in ontology generation and semantic relationship identification (Pisu et al., 2024). BERT-based architectures, in turn, offer accuracy in creating topic hierarchies and performing tasks such as indexing specific research domains (Yang et al., 2023).

These studies highlight the potential of LLMs in trend analysis and in supporting the definition of research scopes, although challenges such as keyword relevance and applicability remain. The next section presents the methodological procedures adopted in this study, detailing the strategies, instruments, and analytical approach.

2. Method

The methodological decisions adopted in this study reflect an exploratory-descriptive typology and a qualitative approach. The object of analysis is the definition of the research scope by undergraduate and graduate students. Students were approached and invited to participate through prior contact with professors of higher education

courses. At the undergraduate level, the courses involved research methodology and aimed at preparing students for their final thesis projects in Pedagogy and various teacher education programs. At the graduate level, students were also enrolled in a research methodology course. The invitation emphasized the voluntary nature of participation, ensuring confidentiality and the protection of students' personal data.

The study sample consisted of 23 students selected "intentionally based on pre-established criteria" (Fragoso, Recuero, & Amaral, 2012, p. 80) relevant to the research project.

The research design involved a data collection process that included the completion of two questionnaires, interspersed with the delivery of a personalized report via email regarding each participant's research scope. To support the preparation of this report, the first questionnaire (Q1) asked students to declare their research topics and questions, along with a brief initial set of keywords, as shown in Table 1.

Table 1. Questions from Questionnaire F1

Question	Format
F1.1. What is the topic of your research project?	Open-ended response
F1.2. What is your research question?	Open-ended response
F1.3. What keywords are related to your research project?	Open-ended response
F1.4. How confident are you in the keywords you have selected?	Likert scale: completely confident; confident; neutral; unsure; completely unsure
F1.5. Which databases do you use to find bibliography?	Multiple choice: Google; Google Scholar; Scielo; CAPES Portal; Repository; Library; Other

In addition to these initial questions, the questionnaire also explored students' level of confidence in their keyword choices and the databases they used during their search process, aiming to better understand participants' research practices.

The collected information served as a starting point for analyzing the preliminary outlines of each student's research project, with the goal of constructing an individualized report. After completing the questionnaire, ChatGPT-4o was used to generate personalized feedback for each student through four prompts:

Prompt 1. Commentary on the research topic and initial keyword set:

I need to evaluate a research project. The research topic is: [...]. The research question is: [...]. The initially defined keywords are: [...]. Comment on the relevance of the keywords to the "research question" and the "research topic," but do not mention the keywords directly. If there are any issues, suggest adjustments and recommend that the student discuss them with their advisor.

Prompt 2. Suggestions for alternative keywords:

Define a set of terms to better delimit the research project. Do not mention the keywords provided by the student. Create an initial outline for the project, presenting other related keywords that may help better frame the research context. Provide a maximum of six keywords in Portuguese, their English translations, and a brief description in Portuguese.

Prompt 3. Creation of a simplified search string:

Create a simplified search string that combines English terms to be used in Scopus to find literature in the relevant field. Combine project-related terms with those suggested in the previous prompt. Include a brief explanation of the purpose of the proposed search string.

Prompt 4. Glossary creation using graph keywords:

Extract the keywords from the graph and create a short glossary including the term in English, its translation into Portuguese, and a brief description of its meaning.

The personalized feedback thus constitutes an initial analysis of the research scope, as illustrated in Figure 1. In Section A of the image (left label), the data originally provided by the student can be seen. Based on this input, the report presented a short review of the keyword selection and suggested expanding it with a complementary set, including definitions and brief comments on their relevance (Section B of the image).

At this stage, Generative AI (GenAI) was used to support the construction of the report. First, an evaluation of the research topic and the initially defined keywords was conducted, including comments on their adequacy and suggestions for improvement. Next, new keywords were proposed, accompanied by brief descriptions, to help expand and refine the project scope. A simplified search string was also created by combining relevant terms for use in scientific databases, along with a short explanation of its intended use.

To compose Section C of the image, an advanced search was performed in the Scopus database using the string defined in the previous step. From this, metadata from the search results was retrieved in BibTeX format—that is, the keywords assigned by the authors of the returned papers, extracted from the DE (Descriptor) field. To ensure effective analysis, a maximum of the first 500 retrieved items was set as a limit.

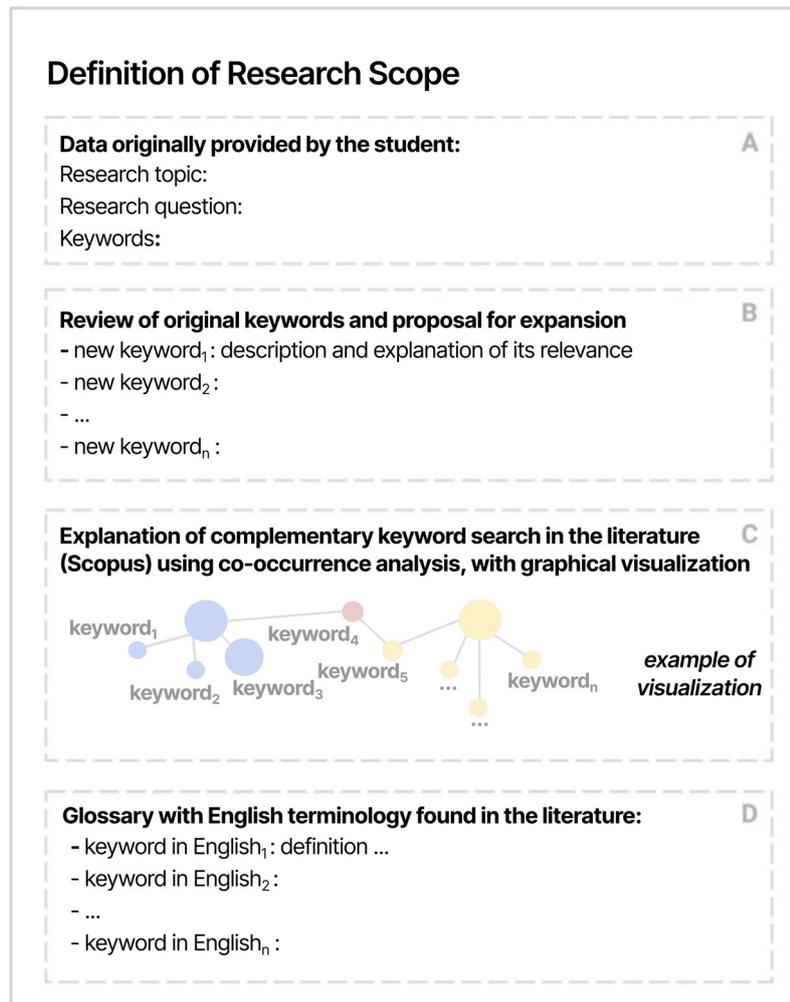


Figure 1. Report Model.

Subsequently, the bibliometric analysis itself was carried out using the Bibliometrix package (Aria & Cuccurullo, 2017) in RStudio. In this phase, specific keyword co-occurrence functions from Bibliometrix were employed, combined with the Fruchterman-Reingold algorithm, which is recognized for its ability to organize nodes (keywords) into clusters, as illustrated in Figure 2.

```
library(bibliometrix)
df.scopus <- convert2df("local/scopus.bib",
  dbsource = "scopus",
  format = "bibtex")
NetMatrix <- biblioNetwork(df.scopus, analysis = "co-occurrences",
  network = "author_keywords", sep = ";")
net=networkPlot(NetMatrix, normalize="association", weighted=T,
  n = 15, Title = "Co-Word Graph",
  type = "fruchterman", size=T,
  edgesize = 5, labelsize=1.4)
```

Figure 2. Code used in Bibliometrix.

As a result of this process, keyword co-occurrence graphs were generated to illustrate the most relevant semantic associations within the context of students' research topics. Figure 3 shows a fictional example of a co-occurrence graph generated for a research project in the field of Education related to the topic "games as a learning strategy."

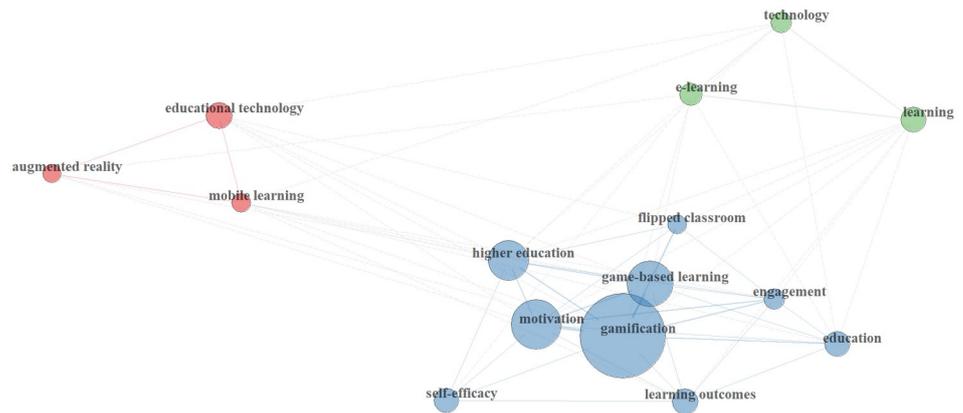


Figure 3. Co-occurrence graph.

Figure 3 displays a co-occurrence network with three thematic clusters: educational technology (red), digital learning (green), and game-based learning (blue). By providing students with a complementary view of the key concepts related to their research topic, the goal was to support scope refinement and improve the bibliographic search strategies adopted, assisting in the identification of connections between relevant keywords. The lines between nodes represent the frequency of keyword co-occurrence. The size of each node indicates how frequently that keyword appears in the corpus. For example, the graph shows that the concept gamification is the most frequent and central, associated with innovative educational strategies in higher education. There is a clear separation between clusters related to methodological innovation, applied technology, and foundations of digital learning, suggesting thematic diversity and meaningful points of convergence for defining research projects. After generating the keyword co-occurrence visualization, the resulting image was saved in PNG format and added to the student's report.

To create Section D of the report (Figure 1), Generative AI was once again used to generate an explanatory glossary of the terms present in the graph, with the aim of supporting the development of search strategies and further refining the scope of the project.

After the report was completed, students received a copy for review and were invited to respond to a second questionnaire (F2), in order to evaluate how much the analysis contributed to the refinement of their initially defined research scope. Table 2 presents the questions and response formats used.

Table 2. Questions from the Second Questionnaire (F2)

Question	Format
F2.1. Did the report on project scope make you reconsider your keyword list?	Simple choice: yes, no, neutral
F2.2. Can you estimate how many of the keywords shown in the graph seemed relevant for use in bibliographic searches?	Ordinal scale by numerical range: all; 9 to 12; 5 to 8; 1 to 4; none
F2.3. After reading the report, how confident are you in the keywords defined for your project?	Likert scale: completely confident; confident; neutral; unsure; completely unsure
F2.4. Did the keyword graph visualization help you understand the scope of your research project?	Likert scale: very helpful; helpful; neutral; not helpful; not helpful at all
F2.5. What is your perception of the usefulness of scope definition for understanding the research topic based on the report received?	Likert scale: extremely useful; useful; neutral; useless; extremely useless
F2.6. Share any positive or negative impressions regarding the keyword definition process for your project.	Open-ended response

The questions in the F2 questionnaire aimed to understand students' perceptions regarding the usefulness of the feedback received and whether they reconsidered their initial keywords. For the initial, quantitatively based questions, descriptive statistical techniques were applied, considering the absolute and relative frequencies of the data collected from both questionnaires. These analyses provided an initial understanding of participants' confidence levels in keyword selection, the perceived usefulness of expanding the research scope, and the estimated number of keywords considered relevant.

For the qualitative analysis, the content analysis method proposed by Bardin (2016) and Saldaña (2015) was adopted to systematize and interpret students' open-ended responses in relation to the two research questions posed in this article.

3. Results

This study investigated higher education students' perceptions of the experience of refining the scope of their research projects through a specific procedure. This procedure combined keyword co-occurrence analysis from bibliographic searches with the use of Generative AI (GenAI) to examine textual elements and generate personalized feedback.

To answer the first research question (RQ1), the study analyzed how the evaluation of the keyword list, along with the graphical visualization of co-occurrences, contributed to revising the list and increasing students' confidence in their keyword choices. For this, responses to questions F2.1, F2.2, and F2.3 from the questionnaire were considered.

The first of these (F2.1) showed that 82.6% of students (19 participants) reported reconsidering their keyword list after reading the report. Two students (8.7%) were unsure, and two others indicated they did not intend to change their list. Regarding the

estimated use of terms from the co-occurrence graph (F2.2), nine participants identified 5 to 8 relevant terms, and eight identified 1 to 4; three stated that all terms were useful, and two pointed to 9 to 12 significant keywords. No participants considered all keywords irrelevant. These findings suggest that, although not all students fully adopted the suggested terms, the visualization helped expand their repertoire and supported the refinement of their search strategies.

Data from the second questionnaire indicated that the majority of students (18, or 78.3%) felt confident about their choice of sources for conducting searches; 3 students (13%) felt completely confident, while only 2 (8.7%) adopted a neutral stance, with no reports of insecurity among participants. When analyzing question F2.3, which explored students' confidence in their keyword selection after receiving the report, it was observed that although the overall absolute frequencies remained stable (Figure 4), significant individual shifts occurred.

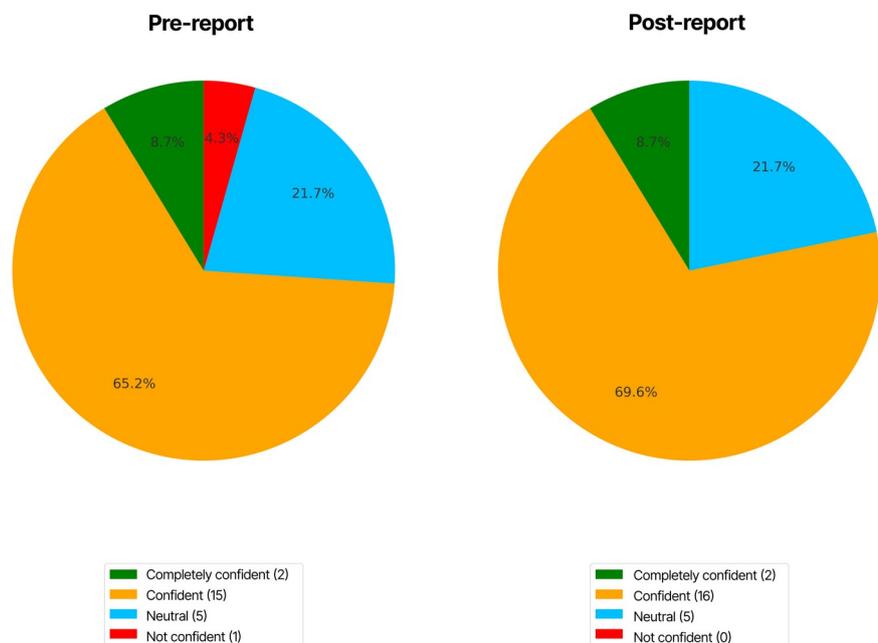


Figure 4. Confidence level in keyword selection.

Absolute counts varied only slightly; for example, the number of students who rated themselves as "confident" showed a slight increase. However, the most noteworthy finding was the internal shifts—i.e., students who, after receiving the report, changed their perception of confidence, either increasing or decreasing their level of certainty (Figure 5).

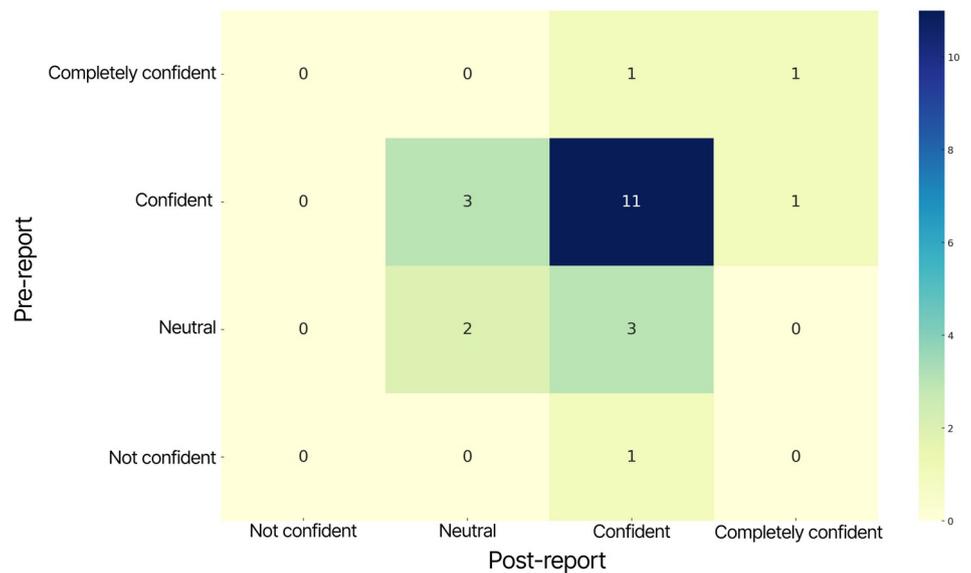


Figure 5. Change in confidence level (pre- and post-report).

The transition matrix in Figure 5 shows that while most students maintained their initial position (11 remained confident), 10 out of the 23 participants changed their self-assessment: three moved from "neutral" to "confident," one from "insecure" to "confident," and two progressed from "confident" to "completely confident," indicating increased self-confidence following the report.

Conversely, three "confident" students repositioned themselves as "neutral," and one student who had been "completely confident" now rated themselves only as "confident." These movements—both in the direction of increased and decreased confidence—reveal a reflective process triggered by the report, suggesting that the intervention prompted critical reassessment of prior decisions. Even transitions indicating reduced confidence may be interpreted as a refinement in students' personal evaluations of their projects.

The analysis of open comments from the questionnaire (F2.5) further reinforced the perception that the intervention contributed to strengthening students' confidence in their keyword selection. For instance, Student 11 noted that "it was possible to rethink the topic and the keywords more clearly," suggesting increased clarity and assurance after receiving the report. Other students, such as Student 8, emphasized the ease of modifying the search string based on the automated suggestions, which may also indicate enhanced instrumental confidence in the refinement process.

Some students, however, noted limitations. Student 16, for example, mentioned that the suggested keywords did not fully align with their project proposal. In this regard, it's important to acknowledge that the application of GenAI to expand keyword sets and the use of co-occurrence analysis in the literature have limitations and may occasionally suggest terms that do not entirely reflect the student's intended project direction. Refining term selection criteria could enhance the system's precision and reduce these mismatches.

Despite such shortcomings, the overall results indicate that the personalized evaluation and keyword visualization contributed positively to expanding students' search repertoire, refining their keyword lists, and either strengthening or critically reassessing their confidence in the choices made for their research projects.

With respect to the second research question (RQ2), which assessed students' perceptions of the usefulness of rethinking their keyword sets for refining the scope of their research projects, responses to questions F2.3 and F2.4 were considered.

Students' perceptions of the keyword co-occurrence graph visualization in helping them understand their research scope (F2.3) were mostly positive. Although "Neutral" was the most frequent response (9 participants), 13 students (56.5%) stated that the graph "helped" (7) or "helped a lot" (6) in understanding their project's scope, indicating that most students recognized the tool's contribution to project refinement. Only one student said the graph "did not help," and none indicated it was "not helpful at all." These results suggest that even when the visual aid did not have a direct impact on all participants, it served to stimulate reflection and reinforce previously made decisions, showing a positive effect on understanding the thematic contours of their projects.

In response to the question about the perceived usefulness of the report for understanding the research topic (F2.4), the evaluation was overwhelmingly positive: 91.3% of students considered the scope report useful (34.8%) or extremely useful (56.5%), while only two participants (8.7%) remained neutral. No students rated the report as useless.

Analysis of the open-ended responses to question F2.6 further reinforced the positive aspects already identified regarding the contribution of the process to understanding the research topic and structuring the project. Statements such as "the scope definition was very positive" (Student 9), "it helped with the development of the research" (Student 17), and "it helped me identify more refined topics" (Student 23) indicate a favorable reception. These comments support the idea that the activity contributed to a clearer and more objective view of their projects. Student 1's comment exemplifies this when stating, "with the scope definition, I feel I have a better overview."

Although most comments were positive, some limitations were also noted by participants. Student 15, for instance, described the scope-definition process as "a bit complicated," and Student 9 acknowledged the richness of the suggested keywords but noted that this also made it harder to identify the central focus of the project. These comments highlight that scope refinement is a dynamic process requiring a balance between breadth and precision. Despite these occasional challenges, the overall responses indicate that the approach was effective in fostering reflection and increasing students' awareness of their research themes. The high rate of positive perception suggests that the intervention not only helped expand their thematic repertoire but also strengthened students' critical understanding of how to define their objects of study.

4. Discussion

The analysis of the results revealed a predominantly positive perception among participants, indicating the formative potential of these technologies—especially when integrated with reflective procedures such as the selection and revision of keywords. The visualization of the co-occurrence graph helped students reconsider their understanding of their project's scope and reformulate their keywords, reinforcing the link between metacognitive skills and information literacy, as pointed out by Tu, Shih, and Tsai (2008).

The use of Generative AI (GenAI) in the educational context, as outlined in this study, created a semi-guided interaction space that fostered students' critical reflection on the feedback received. More than a tool for automatic responses, GenAI functioned as a mediator, providing inputs that required active interpretation and conscious adjustments by students—contributing to the development of autonomy in defining their project scopes. Regarding confidence in keyword definition, the apparent stability in aggregate data masked significant individual shifts: students who were initially uncertain became more confident, while others, initially confident, adopted a more neutral stance after the intervention. These transitions suggest a genuine process of critical reassessment and refinement in understanding the scope of one's own research, aligning with Kuhlthau's theory (2004), which describes the formulation phase as a moment of instability and progressive reconstruction of understanding.

Consistent with studies such as Haman and Školník (2023), this work demonstrates that GenAI can help reduce cognitive load during research planning by supporting the organization and structuring of conceptual repertoires, making it easier to visualize relevant term connections. In the present study, although most students found 5 to 8 graph terms useful, some considered nearly all of them relevant—indicating variations in the degree of alignment between the automated output and the individual project. This variation may be related to project maturity or the initial clarity of the research topic. Thus, rather than merely expanding the number of keywords, the intervention proved effective in supporting students to structure and refine their thinking about their research themes.

The critical perceptions raised by students are also noteworthy, particularly concerning the disconnect between some of the suggested keywords and the specific focus of their projects. This kind of limitation echoes points raised by Peres et al. (2023), who emphasize the dependency on input quality and the need for contextual interpretation as ongoing challenges in effectively applying GenAI in educational settings. These findings reinforce that the use of generative AI technologies must be accompanied by critical mediation—both by students and instructors—to ensure that suggestions are appropriately interpreted and aligned with each research project's goals.

The results also prompt reflection on the integration of technologies such as keyword co-occurrence analysis and GenAI into scientific training curricula. When systematically embedded, these tools can contribute to the development of skills in information searching, organization, and critical evaluation—aligning with Wilson's theory of information behavior (1999) and the principles of meaningful learning. However, their adoption requires more than the mere introduction of new tools: it calls

for pedagogical strategies that promote reflective and critical use of these resources. As Klarin (2024) points out, the iterative and exploratory approach promoted by these technologies is particularly valuable in the early stages of research, when students are still building their understanding of the topic. Nevertheless, their impact will depend on the ability of curricula to integrate these practices contextually, avoiding the risk of purely instrumental adoption.

5. Conclusion

This study demonstrated that the combination of keyword analysis, graphical visualization of co-occurrences, and personalized feedback mediated by Generative AI (GenAI) can be an effective strategy to support students in refining the scope of their research projects. The main contribution of this approach was to enhance students' self-awareness through critical reflection on thematic delimitation, expansion of conceptual repertoire, and increased confidence in keyword selection—essential elements for the development of more structured and well-founded research.

The results also indicated that the effectiveness of the approach described here depends heavily on the quality of the initial information provided by students and the level of maturity of their projects. These factors directly influence the relevance and applicability of the suggestions generated. Therefore, the need for active pedagogical supervision is reinforced, ensuring that these tools are used critically and that the results are contextualized within each student's learning process.

In conclusion, this work shows that the integration of information science and AI opens new methodological possibilities to support students and researchers in navigating the increasing complexity of scientific literature. By structuring strategies such as keyword co-occurrence analysis and AI-mediated personalized feedback generation, it becomes possible not only to organize large volumes of information, but also to foster conceptual refinement and strengthen information literacy.

One limitation of the study concerns the size and composition of the sample, which consisted of 23 undergraduate and graduate students with research projects at different stages of development. This heterogeneity may have influenced perceptions of the usefulness of the tools, particularly in relation to the clarity of research topics and the ability to incorporate the suggestions provided. Furthermore, the intervention was conducted at a single point in the research scoping process, limiting the analysis of long-term effects on project development. Future studies could include ongoing student follow-up to more comprehensively assess the impact of these technologies throughout the various stages of academic research.

6. References

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ARTICLE / ARTIGO

Repositories as public policy instruments for Open Educational Resources: the eduCAPES case

Repositórios como instrumentos de políticas públicas de Recursos Educacionais Abertos: o caso eduCAPES

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Abstract: Educational resource repositories have played a strategic role in digital education policies, especially after the COVID-19 pandemic and the expansion of hybrid and distance education. This article presents a multidimensional analysis of the eduCAPES portal, the main tool for promoting Open Educational Resources (OER) at the Open University of Brazil (UAB). Based on interviews, a questionnaire and documentary analysis, we constructed the trajectory of the portal and the challenges faced in its consolidation. The data point to the absence of a clear identity for eduCAPES, both conceptually as an "OER repository" and as part of a systematized public policy. The study also reveals conceptual, operational and institutional gaps, as well as conflicts among actors and disjointed actions. The analysis shows that, although important initiatives exist, they have not been articulated in a strategic and lasting way. The study also reveals gaps related to the technical aspect. In analyzing the conceptual, technical and political elements, it highlights the importance of integrating repositories into a broader political project. It concludes that, to be successful, public OER repositories must, in addition to offering technical functionalities and optimizations, be anchored in actions that recognize "open" as a conceptual principle and promote the active engagement of the various stakeholders involved in the construction of a structuring policy.

Keywords: Open Educational Resources, Digital Repository, Higher Education, Public Policies, Distance Education.

Resumo: Repositórios de recursos educacionais têm desempenhado papel estratégico em políticas de educação digital, especialmente após a pandemia da COVID-19 e a ampliação do ensino híbrido e a distância. Este artigo apresenta uma análise multidimensional do portal eduCAPES, principal instrumento de promoção de Recursos Educacionais Abertos (REA) na Universidade Aberta do Brasil (UAB). A partir de entrevistas, questionário e análise documental, construímos a trajetória do portal e os desafios enfrentados para sua consolidação. Os dados apontam a ausência de uma identidade clara do eduCAPES, tanto conceitualmente como «repositório» quanto como componente de uma política pública sistematizada. O estudo revela ainda lacunas conceituais, operacionais e institucionais, além de conflitos entre atores e ações desarticuladas. A análise evidencia que, embora existam iniciativas importantes, estas não foram articuladas de forma estratégica e duradoura. O estudo também ressalta lacunas relacionadas ao aspecto técnico. Ao analisar elementos da ordem conceitual, técnica e política, destaca a importância de integrar repositórios a um projeto político mais amplo. Conclui-se que, para que tenham sucesso, repositórios públicos de REA devem, para além de oferecer funcionalidades e otimizações de ordem técnica, ser ancorados em ações que reconheçam o 'aberto' como princípio conceitual, promovam o engajamento ativo dos diversos atores envolvidos na construção de uma política estruturante.

Palavras-chave: Recursos Educacionais Abertos, Repositório Digital, Ensino Superior, Políticas Públicas, Ensino a Distância.

1. Introduction

The Open University of Brazil (UAB) was created in 2005 to promote the development of distance learning in public higher education, focusing on offering undergraduate courses and initial and continuing training for teachers in basic education, as well as expanding and extending the range of courses and programs available in the country (BRASIL, 2006). Currently, with 150 higher education institutions, 1,000 hubs, and 919 active courses (CAPES, [n.d.]-a), and a forecast of 290,000 more openings by 2026 (CAPES, 2023), the UAB today represents the main public distance higher education offering in Brazil.

Since its creation, the UAB system has operated on the basis of a collaborative framework between the federal government, federative entities, and public higher education institutions, which are linked to face-to-face hubs. Its activities are managed collectively by the Diretoria de Educação a Distância (DED) [Distance Education Directorate] of the Coordination for the Improvement of Higher Education Personnel (CAPES); by the Fórum Nacional de Coordenadores UAB (National Forum of UAB Coordinators), made up of representatives from Instituições Públicas de ensino superior (IPES) [Public higher education institutions]; by Regional Forums, which bring together hub coordinators and UAB coordinators; and by Area Forums, which bring together course coordinators from Higher Education Institutions (IES). This decentralized management and operational structure makes the UAB System a challenging environment in which to implement and consolidate its policies, including those relating to processes related to opening up knowledge.

The institutionalization of Open Educational Resources (OER) at UAB, the subject of this study, has many variables involved, as well as a plurality of decentralized institutional dynamics and cultures, which are not always receptive to the changes they bring. OER have characteristics in line with UAB's proposal for expansion and equity. They are capable of impacting the system and its institutions in the sense of reducing costs and broadening the reach of materials produced under the logic of openness, which would, consequently, be a driving factor for the expansion and internalization of public higher education in the country. However, the process for these to become institutionalized within the system has been marked by ups and downs since its conception in the early 2010s, as we will see in this study.

Among the initiatives taken by CAPES, often in collaboration with other actors such as IPES, representatives of public authorities, experts and organized civil society, to introduce, disseminate and maintain a culture of OER in distance higher public education, one of the most notable was the creation of the eduCAPES portal (<https://educapes.capes.gov.br>), currently the main tool for disseminating OER within the UAB. The portal was created by CAPES in 2016, with the aim of meeting the need to share, publicize, and disseminate, at the time, the so-called "educational materials produced in the courses offered under the Open University of Brazil System" (DOU, 2016a; our translation). However, the portal is currently undergoing a period of underutilization, which has led to a reversal of its purpose, as it has been identified as one of the factors, for reasons that will be presented in this paper, that hinder the dissemination of OER on the UAB.

The creation of repositories, referatory, portals, and digital libraries is a central element of an open education policy, more broadly, or of a specific policy for OER, and seeks to expand and guarantee equitable access to quality digital educational resources (Fengchun et al., 2021). As Santos-Hermosa (2023) points out, "The Covid-19 pandemic has reinforced the general need for OER in all educational sectors. Undoubtedly, repositories play a vital role in this field, as they improve and facilitate access to OER" (Santos-Hermosa, 2023, p. 65).

Recent global projects to enhance public portals and platforms in education, such as UNESCO's Gateways to Public Digital Learning, point in this direction (UNESCO, [n.d.]).

Despite their recognized importance and proliferation, we still face significant challenges and a knowledge gap on how to sustain and maintain OER repositories as part of government and institutional policies. These challenges include financial sustainability (Mesquita & Amiel, 2023), data quality and quantity of access (Perifanou & Economides, 2022), and perhaps most importantly, the creation of a culture and practices geared towards openness (Mesquita & Amiel, 2023; Paragarino et al., 2016). Repositories can therefore be central elements in a systemic effort to promote open education (Inamorato et al., 2016).

This article seeks to point out the elements that confirm the need for a systemic outlook for OER repositories, analyzing the case of the eduCAPES portal, in view of the importance of Open Educational Resources in meeting the goals of the UAB and a global agenda in favor of fair and equal access to education. The research also sought to identify, map, and present points of attention related to the use of the portal and its management processes, to serve as a starting point for the development of strategic actions aimed at technical and managerial improvements, to make the role of repositories and portals such as eduCAPES increasingly effective as instruments for the dissemination of OER.

2. Methodology

A multidimensional approach was adopted to analyze the eduCAPES portal, considering the technical, political, and behavioral dimensions involved in its creation and management. The study was based on three main sources of data: interviews, a questionnaire, and documentary analysis.

Semi-structured interviews were conducted with seven strategic participants: four UAB managers, two from CAPES, and one external expert. Identities have been preserved, and the interviewees are referred to in the text by the acronyms CAPES_gestor, UAB_gestor, and Especialista_1. A questionnaire with open-ended questions was also administered to 240 UAB coordinators and vice coordinators, with 55 respondents. The answers were categorized according to their content. Additionally, CAPES institutional documents, regulations, and ordinances related to the eduCAPES portal and UAB were examined.

The research employed a multidimensional analysis technique (Sardinha, 2000) in conjunction with a mixed-methods approach, which integrates qualitative and quantitative data within a single research design (Creswell & Plano Clark, 2018). The

interviews were transcribed and organized according to the criteria of chronology, thematic relevance, and convergence or divergence between the testimonies, with the aim of identifying patterns, conflicts, and complementarities in the portal's trajectory.

3. Results

In Brazil, in the early 2010s, a discussion emerged about public policies based on encouraging Open Education and the use of OER in public educational institutions (Amiel et al., 2018; Rossini et al., 2021). According to Rossini & Gonzales (2012), this discussion was structured along three axes: (1) Public access to educational materials and an open education strategy that includes the individual, the family, the community, and the whole of society in the collaborative learning and production of knowledge; (2) The economic cycle of production of educational resources and its impact on citizens' right to learn; (3) The impact of digital, online, and open resources on teachers' ongoing development.

3.1. OER at UAB: incentive measures or public policies?

These axes underscore the importance of a systemic approach to OER in the context of public higher education, given their strategic potential for achieving the objectives of expansion and equity in access to quality education, as outlined in Decree No. 5,800, which established the UAB System. However, recognizing this importance is not enough for public policies to be formulated and implemented consistently, especially when it comes to a plural context with specific complexities that involve different actors in its management, as is the case with the UAB.

According to the ambiguity-conflict model presented by Matland (1995), the effectiveness of public policies is directly influenced by the levels of ambiguity in their formulation or objectives and conflicts in their implementation contexts. For the author, the greater the ambiguity (in the formulation of policies or their objectives), the more local actors tend to shape the policy, which is why a bottom-up approach or the development of a policy through the participation of the involved actors can be more effective (Matland, 1995).

It is essential to consider the existence of multiple actors and contexts when formulating public policy, as the link between policy design and execution is crucial to its successful implementation. Without considering feedback, local contexts, and realistic implementation, policies can be doomed to ineffectiveness and, in some cases, even generate counter-effects (Birkland, 2019).

In the case of the systematization of the use of OER at the UAB, it is possible to see throughout its history a set of actions, which we can call public policy, outlined and executed by the government, through CAPES, in collaboration with other actors, such as institutions and "policy entrepreneurs" (Kingdon, 2007), individuals who explore opportunities and act to promote change, if we consider their definition from a design perspective.

According to Peters (2015), who develops the concept of public policy from this perspective, it can be understood as a set of activities carried out by both the state and non-state actors that are aimed at solving public problems and defining collective

objectives through processes that involve not only formulation, but also other phases such as implementation and evaluation that occur in institutionalized and interactive contexts. According to Peters (2015), public policy can be understood as a set of deliberate actions taken by public authorities to address collective problems, distribute resources, regulate behavior, or promote well-being. For the author, public policies are not only actions, but also non-actions, i.e., when the government deliberately chooses not to intervene in a problem (Peters, 2015).

To understand public policy from a design perspective is to recognize that it must be conceived as a problem-solving process, considering that public policies will always be more effective when policymakers have a deep understanding of the nature of the problems they face. Furthermore, this approach demonstrates that public policy is a multi-stage process, involving a cycle of formulation, implementation, and evaluation. In other words, it would be a mistake to think that formulation and implementation without evaluation are enough to guarantee results.

3.2. Record

From 2010 onwards, CAPES promoted actions with specialists and UAB editorial commissions to debate OER, copyright, and public policies, laying the foundations for the future institutionalization of the subject. Later, in 2016, the technical report produced by researchers from the UNESCO Chair in Open Education – NIED / Unicamp for the Diretoria de Educação a Distância of CAPES (DED/CAPES) [Distance Education Directorate of CAPES] mapped the level of use and perception of Open Educational Resources (OER) by teachers and coordinators on the UAB system (Soares & Amiel, 2017, p.4). The research was part of a review conducted by CAPES of the policies, actions, and systems aimed at making OER available on UAB.

The report revealed the low level of engagement of UAB coordinators and teachers with the tools created by CAPES to encourage the use and dissemination of OER in the context of the System, highlighting the decentralized nature of the initiatives, that is, each IPES was responsible for its own demands and working conditions in relation to the use of OER on the UAB, except for materials produced from funding distributed through UAB calls for proposals published by CAPES. The latter were based on the premise, set out in the text of the notice itself, that the resources would be deposited on SisUAB - the platform then used to support the execution, monitoring and management of UAB processes, which at that time also served as a "space for the exchange of educational resources produced within the UAB system ". The survey also highlighted that respondents reported unfamiliarity with the SisUAB system, a factor that contributed to the teams' low engagement (Soares & Amiel, 2017).

We can consider that the process of formulating public policies that sought to systematize the use of OER on UAB began in the early 2010s, in line with the movements and discussions surrounding the use and dissemination of OER in Brazilian higher education, as already mentioned. However, the regulations and provisions for effective implementation became public in 2016 with the establishment of the eduCAPES portal and the subsequent publication of CAPES Ordinance 183 (DOU, 2016b), which makes it mandatory to make educational resources produced by UAB scholarship recipients available under an open license, automatically converting them into OER.

The regulations and devices implemented in 2016, including the creation of eduCAPES, came to light amid a climate of low engagement in the UAB community and, in a way, injected new expectations regarding the transformation of this scenario. The report produced for DED/CAPES in 2016 also pointed out that CAPES planned some complementary actions to the launch of the new dedicated repository (eduCAPES) that was being developed at that time, such as a campaign to encourage the deposit of OER by the UAB community, which should have an impact on the engagement of these actors, improving the situation reported in 2016 (Soares & Amiel, 2017).

To identify correlations between changes in eduCAPES, incentive mechanisms, or public policies related to the use of OER on the UAB, and their respective political contexts, we created a chronology of eduCAPES based on materials collected and interviews conducted during the research (Table 1).

3.3. eduCAPES Portal: definition, technical structure, and operational dynamics

eduCAPES was established in 2016 through Ordinance 106, which defines its purpose as "meeting the need to publicize, share and disseminate the materials produced in the courses offered under the Open University of Brazil (UAB) System" (DOU, 2016, p. 14).

CAPES expected that eduCAPES could overcome the limitations of its predecessor, SisUAB, by offering, as a repository, greater support for open licensing, improving the management and accessibility of these educational resources, and allowing interoperability between repositories from other public institutions. In its presentation, eduCAPES is defined as a "portal of educational objects for use by students and teachers in basic, higher and postgraduate education (...)" a portal that "encompasses thousands of learning objects" in different formats and languages, such as textbooks, research articles, theses, dissertations, video lessons, audios, images, among other "research and teaching materials that are openly licensed, published with the express authorization of the author or in the public domain" (eduCAPES, [n.d.]-b)

eduCAPES combines the functions of a repository and a referatory, integrating its own materials and those of partner institutions through interoperability. Here, we consider the definition of repositories as "virtual environments that collect, store, organize, preserve, retrieve, and disseminate the scientific, technological, and intellectual production of an institution or a country" (IBICT, [n.d.]; our translation) and that of referatories as systems or platforms that gather descriptive metadata of educational resources available on the web and do not store the objects themselves, but offer qualified references for access (Distância, [n.d.]).

Developed using the free and open source DSpace software, its structure follows common standards among digital public repositories. Its purpose was initially to meet the need to disseminate the materials created on UAB, but partnerships with institutional repositories were established through interoperability. The first was the repository at São Paulo State University (UNESP), whose creative team was coordinated by the professor who collaborated as CAPES' technical partner in the eduCAPES project, working to support the Coordination of Hub Infrastructure, linked to the technology sector, and who led the project internally. The portal currently has partnerships with 18 institutional repositories, which broadens its reach and integrates content from various public institutions.

Table 1. eduCAPES implementation timeline.

Year	Actions	Scenario
2016	eduCAPES was established by CAPES Ordinance 106 of July 14, 2016. Transfer of materials from SisUAB to eduCAPES Portal awareness campaign Publication of ordinance 183 of 2016, which makes it compulsory to publish educational resources produced by scholarship holders with open licensing	Change in the federal political scene: Impeachment of President Dilma and the inauguration of Michel Temer
2017	Implementation of internal actions for an OER policy at eduCAPES (definition of standards and review of materials) Connection with repositories from other universities	Publication of the technical report on OER at UAB (Amiel & Soares, 2017)
2018/2020	Reduction in eduCAPES management and maintenance activities due to staff shortages Interruption in the collection of statistical data on eduCAPES uploads and use	Bolsonaro Government - Instability in the Ministry of Education (MEC) with successive changes of ministers and dismantling of the technical team, dismantling of directorates, and budget reduction Start of the Covid-19 pandemic Increased turnover of UAB coordinators UAB Forum activities suspended
2021/2022	Initial training and certification course for "OER Ambassadors" at IPES	Period still affected by the pandemic Maintenance of the scenario of political instability (MEC)
2023	Resumption of the collection of eduCAPES statistical data and discussions on improvements and updates to the eduCAPES portal	Beginning of the Lula government Resumption of the UAB Forum Alignment actions between CAPES management and UAB coordinators
2024	Persistent usability problems Publication of CAPES Ordinance 309 updating the guidelines for UAB grants without mentioning the obligation of open licensing	Identification by UAB coordinators of the need to review OER policies

3.4. The eduCAPES implementation process

To this day, SisUAB is UAB's management system, concentrating the flow and organization of its administrative and operational information. It continues to record course offerings, coordinators, centers, and their respective offerings, as well as the number of students, among other important information for the operation of activities. However, its function as a space for sharing educational resources was abolished in 2016 to make way for eduCAPES. The interviews reveal different views on the creation of eduCAPES: while some managers highlight the commitment to open access, others

emphasize the need for centralization and continuity in access to educational materials, which was previously not made possible by SisUAB.

In the same year that eduCAPES was established, a new CAPES ordinance was published in the Diário Oficial da União with the purpose of "regulating the guidelines for granting and paying scholarships to participants in higher education courses and programs in the Open University of Brazil (UAB) System" (DOU, 2016b; our translation). Ordinance 183 made it an obligation for scholarship holders to publish all the material they produced during the grant period as OER. The ordinance did not specify where these materials should be published, nor did it mention eduCAPES. No explicit documents or references were found in the analyzed documents regarding a correlation between this obligation and eduCAPES, which is inconsistent with the strategic perspective of a public policy.

It can be inferred that the merging of repository and referatory functions, as well as the lack of standardization of licenses arising from this dynamic, may have affected UAB managers' perception of their role and possibilities for interaction with the portal (see item 5.1).

In addition to the publication of Ordinance 183 in 2017, CAPES implemented a formal OER policy for eduCAPES in the same year. According to CAPES_gestor_1, the policy aimed to ensure that new content published was licensed openly, which was achieved through two actions: 1. Publication of internal guidelines - creation of rules stating that new materials published must have open licenses, specifically, Creative Commons licenses; 2. Adaptation of publication flows - the process of submitting and validating materials was adjusted to require institutional authors to inform the open license at the time of submission, ensuring compliance with OER guidelines.

On the other hand, printed documents made available by UAB_gestor_1, a set of terms of commitment signed by CAPES grant holders on UAB in their IPES, in a period after these actions, show that the sections where the scholarship holder should indicate the type of open license to be used in the educational resource produced had not been filled in. Furthermore, when asked if there was any control over the scholars' terms of commitment and the licenses used in the materials they produced, all the UAB managers interviewed stated that there was not. These inconsistencies may provide clues to the disparity between the number of materials made available year on year and the corresponding percentage of open licenses.

Development of eduCAPES: the problem and solution streams

The modifications to eduCAPES were motivated by problems that emerged from certain demands perceived as problems to be solved, and were also influenced by changes in political contexts (Table 2). The semi-structured interviews conducted with the actors allowed us to recognize this dynamic, which, for the purposes of analysis, were organized based on the logic of streams for the creation of public policies (Kingdon, 2007). This led us to identify that the development of the portal, the changes implemented, and the actions surrounding it were not the result of a strategic policy or followed a plan with a defined direction.

Table 2. Problem and solution streams in the development of eduCAPES.

Period	Problem Stream	Solutions Stream	Political Stream
2014-2016	Lack of centralization and visibility of educational materials produced under UAB	Creation of eduCAPES	Dilma government (Science without Borders and Open Science programs). International movements for open science and transparency. CAPES takes the technical and normative lead in developing the portal
2016-2017	Problems with licensing materials from other repositories. Low engagement of IPES in the use and deposit of materials	Partnerships with institutional repositories via interoperability. CAPES Ordinance 183/2016, which makes the open licensing of materials produced by scholarship holders mandatory	Context of political instability at the federal level, Change of government from Dilma to Temer
2018	Lack of a specific policy for UAB materials	Institutionalization of the OER concept and training of managers and fellows in partnership with specialists. Development of methodologies for reviewing materials and defining licensing standards (CAPES)	National and international pressure for the adoption of OER in universities
2020-2021	Low flow of uploads and accesses to the portal, and difficulties in the management and technical maintenance of the portal due to a lack of teams	Partnerships with institutional repositories (UNESP), University of Brasília (UnB), and Federal University of Pará (UFPA). Interoperability via the Open Archives Initiative Protocol for Metadata H Temporary suspension of some of the portal's activities	Budgetary and administrative pressures on CAPES. Change of government from Temer to Bolsonaro.
2021-2022	Quality control of the materials sent is limited by the reduction in staff	Implementation of a report system, user evaluations of materials, and curation of the Desenvolvimento de Recursos Educacionais para a Educação Básica Program (PROEB) [Development of Educational Resources for Basic Education Program]	Social demands for transparency in the use of public resources for science

Public policy design emphasizes the importance of aligning objectives, instruments, and institutional contexts (Peters, 2015). Kingdon's model (2007) indicates that policy formulation occurs when problems, solutions, and political conditions converge, creating windows of opportunity. The trajectory of eduCAPES suggests that its changes occurred less as a result of strategic planning and more in response to emerging demands and political circumstances, which contributed to discontinuities and weaknesses in the consolidation of a consistent OER public policy.

Flow of making licensed materials available

Data provided by CAPES in 2024 shows the number of educational resources shared (uploads) on the eduCAPES portal, year by year, between 2016 and 2023, with the percentages of materials published with open licenses (Table 1). The partnership with external institutional repositories increased the volume of materials available, but the increase in OER has not been proportional. A look at the table below demonstrates the peaks in the volume of uploads and the disproportion in terms of open licenses in the same year.

Table 3. Open license resource sharing.

Year	Total of Submissions	Materials with Open Licenses	Percentage: with Open Licenses
2016	2.590	0	0
2017	12.474	123	1,6
2018	16.766	282	2,4
2019	10.6854	1.636	1,7
2020	16.060	590	6,5
2021	49.538	3.840	14,5
2022	220.683	1.785	1,3
2023	10.917	3.663	49,6
Total	43.5882	11.919	4,4

Although data on uploads between 2016 and 2023 has been made available, the lack of distinction between UAB materials and those from other sources makes it difficult to accurately analyze the impact of OER policies on the system. The data provided does not distinguish educational resources from other sources (partnerships with other institutional repositories, materials from the Desenvolvimento de Recursos Educacionais para a Educação Básica Program (PROEB), Strengthening the Network of Government Schools, and other training programmes linked to CAPES) from those published by UAB, which leads to discrepancies in the volume of uploads in specific years, such as in 2022, when the total was 220,683, with materials with open licenses accounting for only 1.3% (Table 1). The same can be said about 2023, when there was the highest rate of uploads of resources with open licenses (49.6%) since the portal was created (Table 1). Although the chronology indicated that this was a year in which various actions relating to eduCAPES and UAB were resumed, it is not possible to gauge precisely to what extent these figures reflect this resumption.

Here, we highlight the strategic importance of surveying and analyzing the portal's data to verify the direct impact of UAB's OER policies. The use of these filters and the systematic monitoring of data based on them could aid in one of the fundamental stages in implementing a well-structured public policy: evaluation (Peters, 2015).

In any case, when we look at the low percentage of openly licensed materials, considering that among them are also those in the public domain that cannot be counted as part of the OER policy on UAB, we realize that, despite occupying a central position in the OER policy for UAB, eduCAPES does not have a proportionally relevant amount of them, capable of characterizing it as an OER repository.

3.5. UAB managers' perceptions of eduCAPES

In the questionnaire used to gauge the perception of UAB managers about eduCAPES, 59.7% of respondents stated that they were not users of the portal, while 35.1% reported using it frequently. There are also 5.2% who can be classified as sporadic users. Among the reasons given for not using the portal, justifications such as "my institution is new to the UAB System" appeared. These cases were not included in the categorization for analysis of the responses, as the study focuses on the history of experience using the portal within the institutions. In any case, it should be noted that the eduCAPES Portal is not presented to new institutions as a structuring tool for their educational resources policy.

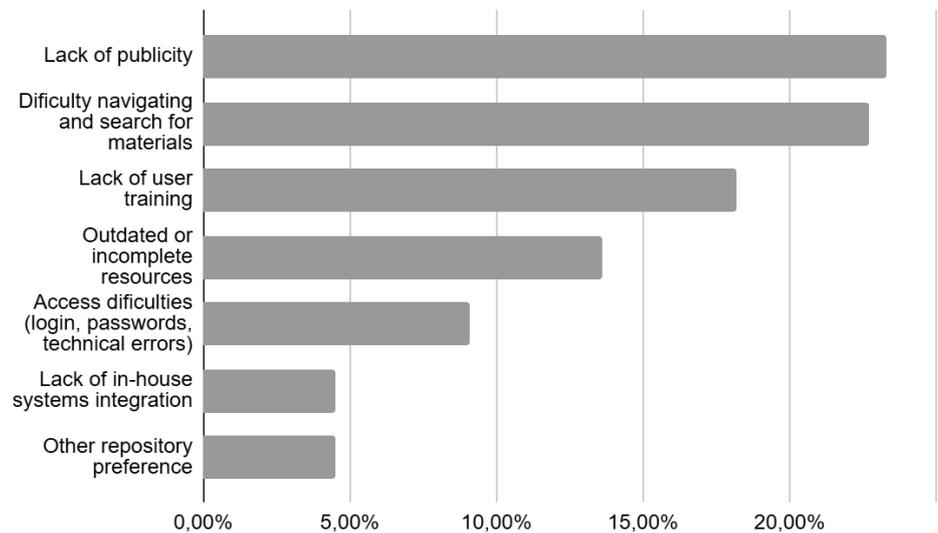


Figure 1. Reasons for not using eduCAPES.

Uses of the portal and types of materials searched for or shared

When asked how eduCAPES has been used by their institution, 43.5% of respondents who identified themselves as users or members of a user institution stated that they use it only to search for material, indicating that only 21% of user respondents/institutions are "active" in the production and sharing of educational

resources. In these cases, the coordinators themselves are mostly responsible for uploading shared materials. In some institutions, there is an official in charge of this task, who may be a librarian or a secretary. The majority of respondents state that there is no specific person responsible for uploads at their institution. Among the most common types of materials published by institutions are books, e-books, and videos.

Obstacles to the integral use of eduCAPES

Observing the obstacles mentioned by the UAB managers in the applied questionnaire allowed us to see the range of points of view among the actors in this category, as well as pinpoint specific aspects to be considered in a possible review of the portal and its uses.

Table 4. Organization of obstacle categories for using eduCAPES.

Obstacle Category	Totals per answer	Total per Category
Lack of knowledge	Lack of publicity in the UAB community (17)	17
Users' technical literacy	Lack of technical knowledge on the part of users (teachers and staff) (9). Lack of technical knowledge on the part of students (5)	14
Management (IPES)	Low adherence at IPES (3); Lack of management for OER production (5); Lack of a person responsible for uploads (2)	10
Functionality and browsing	Access errors (2); Technical problems with the upload system (2); Limitations on the number of new users (1); Difficulty browsing (2); Slowness (1); Search errors (1)	9
Quality of educational resources	Incomplete materials (2); Outdated materials (3); Little diversity of materials (4)	9
Management (CAPES)	Lack of support from CAPES (1); Lack of control over uploads (1); Lack of connection with other repositories (4)	6
Open license literacy	Lack of knowledge about OER on the part of the teams (5)	5
Does not use	Does not use (2); Opts for another repository (3)	5
There are no obstacles	Did not find obstacles (1); No answer (3)	4
Connectivity issues	Lack of equipment, connection, infrastructure (1)	1

The responses also made it possible to observe the level of engagement of the UAB community with the eduCAPES portal and compare it with that presented in the report carried out for DED/CAPES in 2016, which already pointed out similar obstacles, before the creation of eduCAPES, that is, when the OER produced on UAB were still made available via SisUAB (Soares & Amiel, 2017). This leads us to infer that the creation of eduCAPES was unable to solve all the difficulties encountered in distributing OER produced on UAB.

Of the 240 questionnaires sent out, 55 managers answered the question about obstacles to using eduCAPES. The open responses were grouped into ten main categories, as shown in Table 4, ranging from technical and operational aspects to

management and literacy issues. The most recurrent categories were "Lack of knowledge", "Technical literacy of users", and "Management at IPES". The data reveals a variety of obstacles, suggesting the need for coordinated interventions that involve everything from improving infrastructure to training actions and greater institutional coordination. The graph below shows the consolidated distribution of responses.

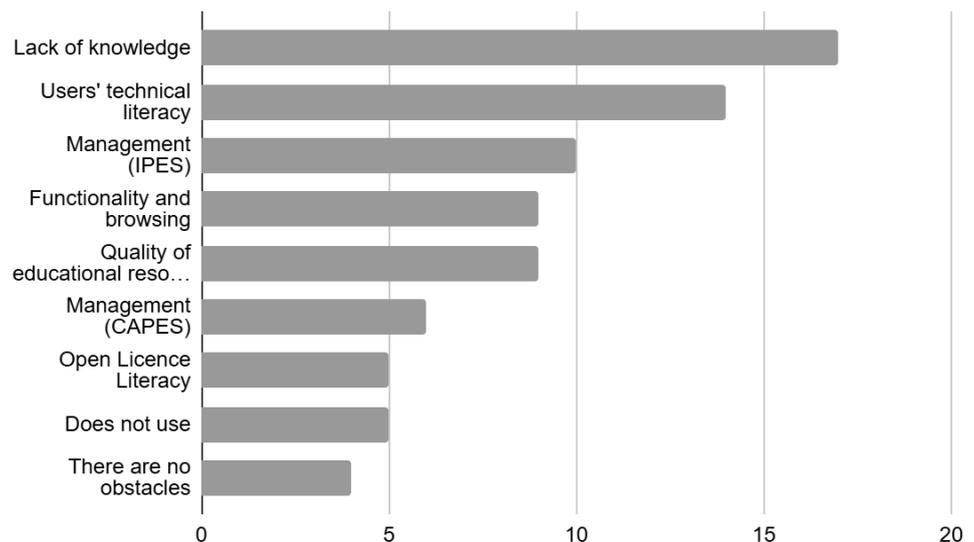


Figure 2. Obstacles for using eduCAPES, by category.

In contrast to the obstacles encountered in using eduCAPES, when asked about any significant contribution eduCAPES has made to their coordination, 49% of the respondents expressed themselves positively. Among these, the contributions mentioned include making quality educational resources available, reducing costs with the development of new materials, and facilitating the the agility of course offering.

Expectations about the portal

The questionnaire asked managers what the role of eduCAPES should have for IPES, UAB, and higher education in Brazil, and the answer with the highest number of incidences was: "to be more publicized". This is not exactly an answer to what the role of the portal should be, but it does provide some clues in regards to the level of engagement among the respondents. The other answers also fall short of expressing an expectation for eduCAPES from a strategic point of view in higher education. They are more operational in nature and appear as suggestions for technical implementation or ways to improve management.

Among the suggestions made by the managers were improvements in the curation of the collection, in navigational tools, organization by area of knowledge, as well as greater integration with other platforms, and technical training initiatives. Although the focus of the responses was more on operational issues, some comments indicate recognition of eduCAPES as a source of materials and a tool to promote the democratization of access to knowledge.

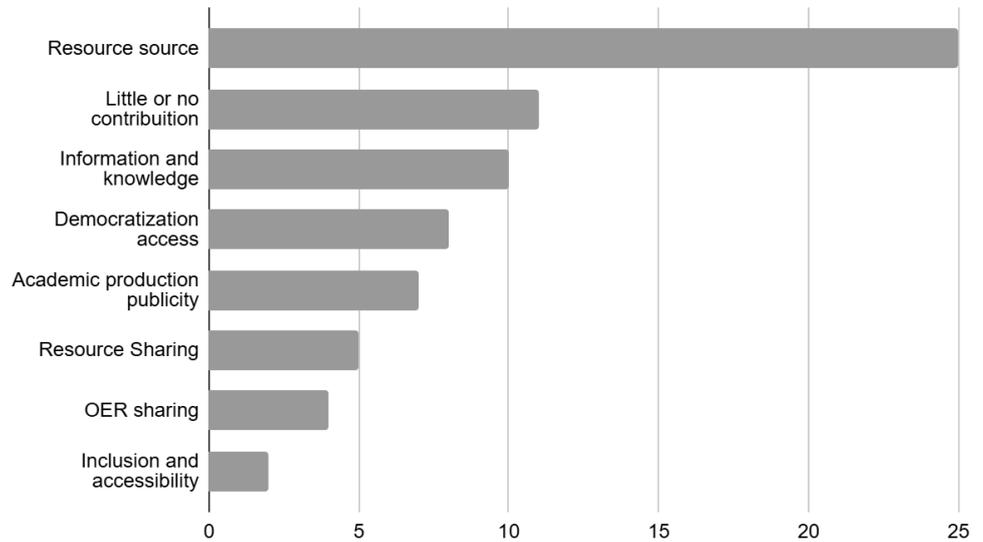


Figure 3. eduCAPES' contributions to UAB and higher education

However, when asked what eduCAPES' contributions to the UAB would be, the answers showed that eduCAPES has a role that is concentrated along two lines: 1) source of materials and 2) democratization of access (Figure 3).

3.6. Analysis of results

The results obtained reveal the existence of different layers of controversy surrounding the role of eduCAPES in the context of the UAB as an instrument of public policy aimed at Open Educational Resources (OER). These controversies are manifested in three main dimensions—conceptual, technical, and political—and in many cases, they operate in an interdependent manner. Although the portal was set up with the aim of making public the educational materials produced under the UAB, its trajectory is marked by disputes over meaning, regulatory gaps, asymmetries in engagement, and uncertainty about its role.

Regarding the conceptual dimension, what can be observed is a scenario marked by strong ambiguity, as defined by Matland (1995), who associates the concept with vagueness in the objectives, values, or languages present in the formulation of public policies. The term OER, which should structure the design of eduCAPES, appears in a fragmented and imprecise manner and is not even mentioned in official documents. There is a coexistence of terminologies — "learning objects", "educational materials", "educational resources", and "digital content" — without a clear explanation of the conceptual framework that guides the policy. This lack of definition undermines alignment between the different actors involved, since there is no common vocabulary to establish commitments, guide practices, and organize responsibilities.

Conceptual ambiguity, in this context, acts as a factor of dispersion, as different interpretations of what is expected of the portal coexist without being explicitly stated or clarified. This contributes to eduCAPES being perceived sometimes as a technical repository, and other times as an access referatory, and also as an institutional

showcase. Without a clear and shared conceptual framework, each actor or institution tends to interpret its use based on one's own logic, which can lead to discontinuity, misalignment, and low appropriation. As Matland (1995) points out, in contexts of high ambiguity and low conflict, the symbolic model of implementation tends to prevail, where actions occur more to signal commitments than to produce effective transformations.

Regarding the technical dimension, the identified challenges encompass both the structural aspects of the portal and the operational and maintenance flows. Browsing difficulties, lack of integration with other systems, limitations in search mechanisms, curation and usability flaws compromise the user experience and feed a perception of the low effectiveness of eduCAPES. Added to this are the difficulties reported by the teams in carrying out uploads, the lack of a specific person in charge at the institutions, and the lack of technical support and systematic guidance on licensing and publishing OER.

Finally, in the political dimension, the results indicate that the development of the portal was significantly influenced by changes in the institutional landscape and administrative instability. The chronology of actions reveals how the advancement or retraction of OER policies within the UAB was subject to the confluence of external factors, one-off decisions, and discontinuities in management. The lack of a consolidated formal policy, a lasting action plan, and regular evaluation mechanisms makes it difficult to consolidate eduCAPES as a public policy. In many cases, the actions were more reactive than strategic, and the portal began to incorporate content and functionalities without a clear understanding of its long-term objectives, which contributed to its de-characterization.

For example, Table 2 summarizes the main changes made to eduCAPES over time, along with the respective factors that motivated them, illustrating the logic of responding to emerging problems rather than strategic planning. Table 3 organizes the categories of obstacles identified by UAB managers in relation to the portal's use, highlighting the structural, operational, and cultural aspects that affect its effectiveness.

All of these analyzes together indicate that eduCAPES is part of a field of disputes and uncertainty, in which the potential of a public repository aimed at disseminating OER remains latent, but not fully realized. The lack of conceptual clarity, coupled with technical weaknesses and political fragmentation, hinders the portal's understanding and effective use as a strategic instrument for public policy to promote open access and the democratization of knowledge in Brazilian higher education.

4. Conclusion

The analysis of eduCAPES reveals that although actions have been taken to promote the use of Open Educational Resources on UAB, they have not yet been integrated into a structured public policy. What can be observed is a sequence of relevant initiatives, but which have taken place with limited coordination, often influenced by changes in the institutional and political context. The conceptual ambiguity surrounding the meaning of OER, the overlapping functions of repositories and referatories, low levels of engagement among managers, and the accumulation of technical and operational

obstacles reinforce the perception that the portal still lacks a clear identity and a shared strategy.

We conclude that public repositories, such as eduCAPES, can play a crucial role in OER policies in Brazilian public higher education. Repositories should be treated as strategic instruments within systemic policies to promote OER, rather than focusing solely on their potential as a technical solution. We suggest that it is necessary to promote and guarantee the articulation and confluence between the conceptual, technical, and political orders. Without this, there is a risk that these repositories will remain underutilized, contributing little to the promotion of collaborative practices and more open education, which should guide OER policies.

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ARTICLE / ARTÍCULO

Open Educational Research Data: Are Repositories Delivering?

Datos abiertos en investigación educativa: ¿cumplen los repositorios su función?

Gonzalo Tortero-Silva y Regina Motz

Abstract: Situated in today's digital context, where the open science movement is a new paradigm for the production and circulation of knowledge, this paper analyzes the extent to which research data repositories meet the technical, legal, and ethical needs of researchers in the education and the social sciences domains. The methodological approach combines a literature review, an expert interview, and analysis of repository catalogs. From the fusion of the obtained results, it can be concluded that the characteristics of repositories that are most valued by researchers in these disciplines are reputation, ease of use, availability of contextual information, sustainability (long-term data preservation), technical support, and compliance with FAIR principles (which promote the production of Findable, Accessible, Interoperable, and Reusable data). In addition, this article delves into the role that repository catalogs play in facilitating the selection of appropriate repositories for depositing data, providing researchers with useful information for determining whether specific repositories meet their needs. This study provides valuable information for promoting the adoption of open data practices in the field of educational research.

Keywords: Research Tools, Archives, Online Catalogs, Metadata, Data Use.

Resumen: En el contexto digital actual, que tiene al movimiento de la ciencia abierta como un nuevo paradigma de producción y circulación de conocimiento, este trabajo analiza en qué medida los repositorios de datos de investigación responden a las necesidades técnicas, legales y éticas de los investigadores en educación y ciencias sociales. El abordaje se realiza aplicando un enfoque que combina tres actividades: revisión bibliográfica, entrevista a experto y análisis de catálogos de repositorios. De la fusión de los resultados obtenidos, se concluye que las características de los repositorios que resultan más valoradas por los investigadores de estas disciplinas son la reputación de los repositorios, facilidad de uso, disponibilidad de información de contexto, sostenibilidad (conservación de los datos a largo plazo), apoyo técnico y cumplimiento de los principios FAIR (que promueven la producción de datos Encontrables, Accesibles, Interoperables, Reutilizables). Además, este artículo profundiza en el rol que cumplen los catálogos de repositorios para facilitar la selección de repositorios adecuados para depositar los datos, proporcionando a los investigadores información útil para evaluar la calidad de los repositorios, en cuanto a si responden a sus necesidades. Este estudio proporciona información valiosa para promover la adopción de prácticas de datos abiertos en el campo de la investigación educativa.

Palabras clave: Herramientas de investigación, Archivos, Catálogos online, Metadatos, Uso de datos.

1. Introduction

In today's digital age, the open science movement has profoundly reshaped the paradigms of scientific knowledge production and circulation. Within this transformative framework, public access to research data emerges as a fundamental strategic component, particularly in the field of education. The application of these paradigms not only strengthens the pillars of transparency and reproducibility that underpin the scientific method (OECD, 2020), but also facilitates secondary analysis and contributes to the social impact of knowledge (European Commission, 2016; Wilkinson et al., 2016). The potential benefits are particularly significant in the field of education, where the possibility of comparing results obtained in different sociocultural contexts and pedagogical systems could generate inputs for the evolution of public policies in education.

UNESCO (2021, p. 10) conceptualizes open research data as data that must be «available in a timely manner, in a format that is easy to use, readable, and modifiable by people and machines», as articulated under the FAIR (Findable, Accessible, Interoperable, and Reusable) principles (Wilkinson et al., 2016). The availability of repositories aligned with these principles facilitates the task of researchers, both in terms of depositing and reusing data. However, it is not trivial to decide which repository should be used to deposit, organize, and manage research data. In this regard, the TRUST principles (Lin et al., 2020) represent a valuable reference framework for evaluating the quality of scientific repositories, promoting Transparency (clear usage policies), Accountability (in terms of data collection management), User Focus (availability of tools for exploring, locating, and reusing data), Sustainability (availability of long-term data access services), and Technology (use and implementation of appropriate standards and tools for data management and curation). The comprehensive characterization by Behnke et al. (2020) details how these principles include both organizational requirements (such as clear data management policies and support for standard formats) and technical requirements (from granular metadata to persistent identifier systems).

The organization and grouping of research data collections in repositories responds to different criteria according to which it is possible to broadly categorize repositories as disciplinary (when they contain data from a specific area of knowledge), generalist, and institutional (if they house data from a particular institution). Moreover, in some disciplines, such as economics or epidemiology, most of the data managed is quantitative, while in others, such as the social sciences and education, the data is mostly qualitative. Each of these repository types may require the prioritization of some principles over others, or the use of different standards or technologies for their implementation. In general, as research data from the same discipline share many characteristics, the technological requirements are similar. In this respect, educational research faces specific obstacles, especially when working with qualitative data which, as Antonio et al. (2019) point out, require exceptional levels of contextualization and specialized ethical protection mechanisms, implemented with specific technologies, which many generalist repositories are not prepared to offer. Other as authors, including Strecker, Pampel, Schabinger, and Weisweiler (2023), report on the risks of these repositories in meeting quality standards, further indicating that repositories related to the humanities and social sciences are among the most affected by such problems. Benjelloun, Chen, and Noy (2020) and Gerasimov, Binita, Mehrabian, Acker,

and McGuire (2024) also warn about trends toward centralization of most datasets in generalist repositories. Paradoxically, several recommendations from these generalist repositories encourage researchers to use disciplinary and institutional repositories (Barbosa et al., 2024). In particular, the works of Ávila Barrientos (2024) and Song, Li, and Chansanam (2025) stand out for their comprehensive analysis of guidelines for selecting reliable scientific data repositories. International organizations such as the OECD (2020) and UNESCO (2021), aligned with the FAIR and TRUST principles, have also promoted policies that encourage the use of specialized digital repositories for the storage, preservation, and ethical dissemination of scientific data.

As Borgman, Scharnhorst, and Golshan (2018) argue, these digital infrastructures are no longer mere repositories of information but have become fundamental nodes in contemporary knowledge production networks, facilitating not only access but also interoperability and the progressive enrichment of datasets through successive reuses. Along the same lines, the recent conceptualization by Ávila Barrientos (2024, p. 27) emphasizes their role as dynamic systems that allow for «the storage, organization, retrieval, and access of datasets of diverse thematic and typological nature,» thus constituting essential drivers for open science.

The application of the FAIR (Wilkinson et al., 2016) and TRUST (Lin et al., 2020) principles faces particular challenges in disciplines such as education and the social sciences, where the heterogeneity, sensitivity, and complexity of data make it difficult to standardize and create specialized infrastructures aligned with the requirements of these disciplines. However, the scarcity of disciplinary repositories in these areas, coupled with ethical, legal, and cultural challenges, forces most researchers to rely on institutional or generalist repositories, which do not always meet the specific requirements for optimal management of educational and social data.

As Borgman (2016) warns in his analysis of knowledge ecologies, data only achieve their full scientific value when they are integrated into robust ecosystems that coherently articulate technical, community, and institutional dimensions. It is this articulation that presents particular challenges in the field of education and social sciences, where specialized disciplinary repositories are scarce compared to those pertaining to other areas of knowledge (Krähmer, Schächtele, & Schneck, 2023; Lamb et al., 2024). This disparity is paradoxical when we consider the intrinsic complexity of educational data, which ranges from standardized quantitative measurements to deeply contextualized ethnographic records, often containing sensitive information (e.g., about minors in specific school environments; Gomes et al., 2022).

Faced with these challenges, initiatives such as re3data (Pampel, 2013) have sought to create integrated catalogs that facilitate the location and evaluation of specialized repositories. The informed selection of repositories thus becomes a crucial challenge. In this context, repository catalogs emerge as key tools for searching, filtering, and evaluating options according to technical, ethical, and disciplinary criteria.

However, when it comes to repositories of educational research data, there is very little disciplinary presence. For example, according to information collected in June 2025, the FAIRSharing, DataCite Commons, and re3data catalogs respectively have 1,252, 1,767, and 3,259 repositories registered, only 22, 5, and 47 of which correspond to research data repositories in the field of education.

In this sense, we believe that this work contributes to drawing attention to the needs of education researchers in order to continue improving the service that repositories can offer them, thereby encouraging their development.

Accordingly, in this article, we analyze the need for data publication in education and social sciences, and the characteristics of the repositories most valued by researchers in these disciplines, considering their ethical, technical, and legal concerns. In addition, we explore the role of repository catalogs in the informed selection of repositories, with the aim of strengthening the culture of open data and contributing to the advancement of open science in these disciplines.

2. Methodology

This study was conducted using a sequential exploratory methodological design with the following three interrelated phases: Literature Review, Expert Interview, and Catalog Analysis. Its objective was to identify how repositories respond to the ethical, technical, and legal concerns that researchers have when depositing data from educational research

2.1. Methodological Phases

- Phase 1. Literature Review. Various sources were used: articles in Scopus/WoS (keywords: 'open data' + 'education research' + 'concerns'), as well as UNESCO and OECD reports. Exclusion criteria included: studies on open educational resource repositories and works that focus solely on open access to research publications. For the analysis, assisted coding was applied using Elicit1 to categorize recurring concerns (e.g., privacy, intellectual property, additional effort). The expected outcome was a conceptual map of barriers documented in the literature (2015–2025).
- Phase 2. Expert Interview. The person responsible for the open data repository of the National Agency for Research and Innovation (ANII) of Uruguay was interviewed. The instrument (protocol) was a semi-structured interview lasting 45 minutes. For the analysis, the interview was transcribed and coded in order to confirm or refine the categories identified in the literature.
- Phase 3. Repository Catalog Analysis. A sample of six internationally widely used catalogs was analyzed (OpenDOAR, ROAR, OpenAIRE, FAIRSharing, DataCite Commons). The variables evaluated were: repository activity, creation of persistent identifiers, support for specifying context, compliance with interoperability standards, adherence to licensing policies, and sustainability.

For data triangulation and validation, the three methods: literature review, expert consultation, and catalog analysis, were combined, allowing for the triangulation of information and increasing the validity and reliability of the results.

3. Resultados

In this section, we present the results yielded by the literature review, expert consultation, and analysis of repository catalogs.

3.1. Results of literature review

Although numerous studies have focused on identifying the factors that influence researchers' willingness to share their data openly, only the key works focusing on repositories are highlighted here. A comprehensive review of extant literature reveals that a variety of data collection methods and analytical approaches are adopted in these studies, including surveys, systematic literature reviews, meta-analyses, focus groups, and round tables (Barczak, Hopp, Kaminski, Piller, & Pruschak, 2022; Borycz et al., 2023; Casali, Motz, & Sprock, 2022; Grattarola, Laufer, et al., 2024; Logan, Hart, & Schatschneider, 2021; Mosha & Vincent, 2024; Shamsudin, Zain, & Sahid, 2025; Tenopir et al., 2011; Thoegersen & Borlund, 2022; Zuiderwijk, Shinde, & Jeng, 2020). It is interesting to note that most of these studies were conducted with researchers from different disciplines, with different levels of expertise and from different geographical contexts. Curiously, few of these studies have been studies conducted with education sciences researchers, such as Casali et al. (2022), who analyzed survey responses provided by the LACLO (*Latin American Conference on Learning Technologies*) attendees. On the other hand, Logan et al. (2021) and Neild, Robinson, and Agufa (2022) present guidelines on open data publication specifically aimed at researchers in education.

While the work of Casali et al. (2022) highlights barriers such as the time and effort required to share data, the lack of funding for data standardization, and restrictions related to data security and confidentiality, Logan et al. (2021) and Neild et al. (2022) pay special attention to procedures for maintaining data security and confidentiality, as these are recognized as the most common problem.

Most of the researchers in this field agree that the extra effort involved in curating data for open publication is an important hindrance to the establishment of repositories. While this problem is generally attributed to the development of repositories that are not very user-centric, some authors argue that it is due to a lack of administrative support for researchers in preparing data (Borycz et al., 2023; Casali et al., 2022).

More recently, Grattarola, Shmagun, et al. (2024) and Mabile et al. (2025) pointed out that the main disincentive to sharing data openly is the lack of institutional incentives and recognition for data publication. With regard to qualitative research data, all authors highlight the problem of having elements that allow the context in which the data were obtained to be specified and the concern for having specific curation to ensure researchers' protection from the legal and ethical problems arising from using sensitive data.

Qualitative researchers in the social sciences mention issues related to the privacy of their data and the ethical commitment involved in its publication. In the social sciences, data are usually provided by or relate to study participants, and even if they are anonymized, many researchers fear that participating individuals may be re-identified, especially when data was collected in small communities or relates to sensitive topics (Krähmer et al., 2023). Despite the existence of mechanisms to mitigate this issue, such as informed consent, the responsibility of repositories for data custody is not always easy for data producers to understand (Prosser et al., 2022).

In their work, Lamb et al. (2024) confirm some of the challenges inherent in qualitative research. According to their findings, qualitative data (such as interviews or field diaries) require in-depth contextual knowledge to be interpreted properly when other researchers decide to reuse the dataset.

3.2. Results of expert consultation

The conclusions drawn from the expert interview are based on an internal study conducted by the National Agency for Research and Innovation (ANII). Although unpublished, this study provided valuable information on researchers' perspectives in the context of Uruguay. The ANII study revealed that researchers tend to perceive themselves primarily as consumers of data rather than producers. This perception influences their expectations and needs in relation to data repositories. Discussing the findings yielded by this study, the expert interviewed highlighted three key characteristics that researchers consider essential when publishing their data:

- a) Assignment of persistent identifiers: The assignment of unique and permanent identifiers, preferably Digital Object Identifiers (DOIs), is seen as a fundamental requirement, especially since many scientific journals require them for the evaluation and citation of articles.
- b) Sustainability and durability: The repository's ability to guarantee long-term data preservation is considered crucial to ensuring its availability and future reuse.
- c) Interoperability: The repository's ability to facilitate data integration and exchange between different platforms and systems is considered essential for maximizing the impact and reuse of data.

The semi-structured nature of the interview facilitated in-depth exploration of relevant topics without restricting the spontaneity of the dialogue, which helped to validate and expand the results of the bibliographic survey with empirical evidence and direct experience.

3.3. Results of the repository catalog analysis

As a part of their studies, Witt et al. (2024) and Song et al. (2025) established the main criteria for evaluating research data repositories. However, these authors point out that researchers face obstacles in verifying compliance with these criteria, given the limited accessibility of this information a priori. This limitation makes it difficult to select a suitable repository for the publication and reuse of data. Guided by this observation, in this paper, we analyze the role of repository catalogs in the efficient dissemination of such information, taking as a reference the criteria defined by these authors and those developed by the Data Repository Attributes Working Group 1. The characteristics we seek to identify are: repository activity, creation of persistent identifiers, support for specifying context, compliance with interoperability standards, and adherence to licensing and sustainability policies.

Repository activity

The activity factors of the repository and disciplinary specificity strongly determine the visibility and reuse of data. Recent repository activity is a key indicator of its reliability. Indicators of activity include the frequency of updates (e.g., new datasets deposited

monthly), date of the last dataset deposited (researchers should avoid repositories with no activity in the last 12 months), and public statistics (e.g., number of downloads or citations in DataCite).

On the other hand, a repository specializing in a subject area offers the significant advantage of using specific metadata schemas (e.g., DDI¹ for social sciences), which improves interoperability and data discovery. In addition, thematic repositories attract specialized users, which increases the impact and citation of stored datasets.

Creation of persistent identifiers

The DOI plays a fundamental role in research data repositories, as it guarantees the location, citation, and permanent preservation of datasets. It provides a unique and stable link, preventing data loss due to changes in URLs or outdated repositories. This ensures that datasets remain accessible in the long term, complying with FAIR principles. By integrating with bibliographic management systems (such as Crossref or DataCite), the DOI allows datasets to be linked to scientific articles, improving their visibility and facilitating the tracking of their impact.

The DOI is assigned by authorized registration agencies, with DataCite being the most widely used for research data or by repositories/institutions affiliated with DataCite. In some cases, the same dataset may be associated with multiple DOIs. This can happen if a researcher uploads the same dataset to different repositories and each one assigns it a different DOI, or in the case of updates or versions, as some repositories generate a new DOI for corrected or expanded versions of the same dataset. This practice is undesirable as citations to the dataset are scattered across multiple DOIs, underestimating its real impact and making it difficult to identify which is the most up-to-date version. To avoid these problems, it is recommended to prioritize the use of reference repositories in each discipline (e.g., ICPSR in social sciences) to avoid duplication. If this is not possible, using repositories that support versions under the same DOI and linking alternative DOIs using metadata (`isVersionOf` or `isIdenticalTo` relationships in schemas such as Schema.org) is advised.

Support for documenting context

The context of a dataset includes details about its origin, the methodology used to generate it, its potential uses, and its limitations. Repositories collect contextual information through descriptive metadata, technical documentation (such as laboratory protocols, questionnaires, or processing scripts), additional documents (such as readme files, guides, and reports), and linked publications (DOIs of related articles in which the dataset was used or cited). The descriptive metadata must include at least the following information:

- a) Origin: Who created it (institution, research project, authorship) and temporal/geographical coverage (when and where the dataset was generated).
- b) Purpose: Objective of the collection.
- c) Collection methods: Instruments, protocols, or software used.
- d) Licenses and restrictions: Conditions of use (CC-BY, GDPR, restricted access).

¹ <https://ddialliance.org/>

Catalogues such as OpenAIRE and DataCite Commons promote the use of international standards (such as the OAI-PMH protocol and FAIR metadata), which ensures that data is easily locatable, accessible, and reusable by different platforms and systems, fostering collaboration and information exchange between scientific communities. This best practice of using controlled vocabularies and disciplinary ontologies (e.g., OECD Education Taxonomy) to facilitate interoperability is promoted by FAIRSharing, which offers a curated directory of metadata standards among its features. When a repository is indexed in FAIRSharing, it evaluates and recommends specific metadata standards according to its discipline.

Compliance with policies

Another aspect to consider in a repository, which depends on political or legal factors, is its usage and preservation or sustainability policies. The problem of repositories becoming extinct is highlighted by Strecker et al. (2023). Some catalogs, such as FAIRSharing, facilitate the evaluation of these factors, allowing the relationship between the specific policies of each repository and more general policies to be identified.

If we take the example of the NIH² as a funder, it could impose compliance with its terms of data use³. FAIRSharing is capable of displaying repositories that are compatible with this policy, as depicted in Figure 1. Aided by this functionality, a researcher with an NIH-funded project can limit the selection of repositories to those found in the query that produces the graph in Figure 1.

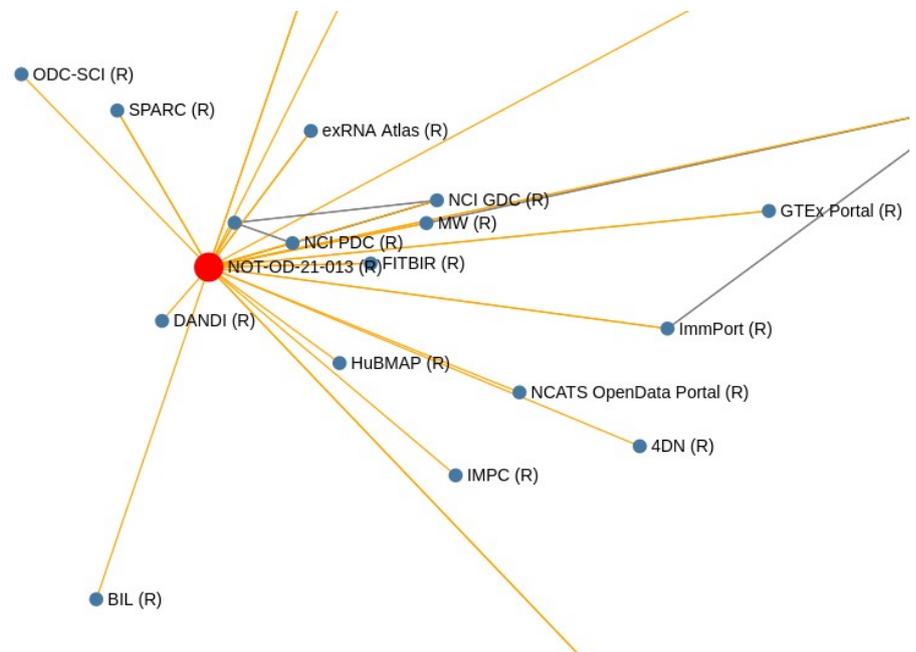


Figure 1. Graph of repositories that use the NIH policy – FAIRSharing (Retrieved on 2025/06/26).

² <https://www.nih.gov/>

³ nih_policy_fairsharing] 2023 Final NIH Policy for Data Management and Sharing - <https://fairsharing.org/FAIRsharing.7861ef>

Another mechanism that helps identify repositories' adherence to certain usage and sustainability policies is certification. Repository certifications are external evaluation mechanisms that guarantee that a repository complies with quality, preservation, and best practice standards in data management. Certifications are especially useful for determining whether repositories adhere to preservation or sustainability policies. For instance, a certification indicates that a repository has demonstrated some of the following functionalities: it assigns DOIs, uses disciplinary metadata schemas, has a sustainable technical infrastructure (backups, format migration), offers version management for change control in datasets, has technical support to respond to incidents, and is backed by a stable institution (university, public body). Different certification seals signify different functionalities. For example, a repository with CoreTrustSeal⁴ seal confirms that a repository has undergone a thorough verification of legal compliance criteria (e.g., GDPR, intellectual property) but not of DOI assignment.

The catalogs compile data from certifying bodies and standardize the display of certifications to facilitate comparison. For example, re3data shows the year of certification and its validity. FAIRSharing does not certify, but rather evaluates and recommends repositories that adhere to the use of metadata standards and FAIR principles. It also includes a filter by certification (e.g., CoreTrustSeal, ISO 16363⁵) and provides links to official certification reports. A researcher looking for a repository for education data can use FAIRSharing and filter by CoreTrustSeal, as well as check in re3data to see if the repository has a valid certification.

Repository compatibility with services

Knowing the repository's capacity to provide or integrate with certain specialized services in a particular research area, as well as the conditions under which it provides these services (price or level of availability), may be relevant to researchers. Some of these services and functionalities include the ability to perform or receive formal reviews, the possibility of establishing embargo periods, specialized technical assistance, or the availability of disciplinary curation services.

In particular, in the case of qualitative research data repositories, the presence or integration of services such as anonymization or access control mechanisms is valuable to researchers. Catalogues such as OpenAIRE provide information on the integration of different repositories with the EOSC service ecosystem. For example, using the «Compatibility Level» filter, researchers can view the repository's level of compatibility with services such as Amnesia⁶ anonymization service, OpenAIRE AAI⁷, API for access service, and «Argos»⁸ Data Management Plan service, among others. Table 1 provides a summary of the main features of the repository catalogs reviewed.

⁴ <https://www.coretrustseal.org>

⁵ <https://www.iso.org/standard/87472.html>

⁶ <https://www.openaire.eu/amnesia-guide>

⁷ <https://catalogue.openaire.eu/service/openaire.aai/overview>

⁸ <https://catalogue.openaire.eu/service/openaire.argos/overview>

Table 1. Main features of six repository catalogs in focus of this work.

Catalog	Features
OpenDOAR	Provides basic information about the repository.
ROAR	Similar to OpenDOAR, but allows users to find out the discipline associated with the repository. Specializing in academic publication repositories, it also contains research data repositories on an occasional basis.
Re3data	Specializes in describing research data repositories. Provides the largest number of repository records. Its publication on certification validity is very useful.
FAIRsharing	It allows users to navigate between the relationships between standards and policies and different data repositories. Standards include FAIR principles, TRUST, and various certifications. It includes various repositories (data, documents, multimedia, software, etc.).
DataCite Commons	It integrates information on various types of research repositories and stands out for providing concise information on their content, although it does not allow users to explore certain characteristics of the repository in detail, nor does it offer advanced filtering criteria like re3data.
OpenAIRE	Similar to DataCite, it allows users to view, but not navigate between, repository relationships, making it less useful than FAIRSharing. It stands out for the quality with which it handles data provenance, allowing users to see which repositories share content and which catalog the repository information comes from.

4. Conclusion

The following section presents the findings obtained from the results of the applied methodology. The findings are summarized in Table 2. The first column shows the characteristics of repositories that meet the needs identified by researchers listed in the second column, and the third column lists the catalogs that, to a greater or lesser extent, provide information that allows researchers to identify which repositories meet those characteristics.

Table 2. Features of repositories most valued by researchers.

Feature	Researchers' needs	Catalog providing information
Activity, Reputation	Recognition	Re3data, FAIRSharing, OpenAIRE
Technical support	Less effort	FAIRSharing, DataCite Commons
Metadata availability	Context information	FAIRSharing, DataCite Commons, OpenAIRE
Compliance with FAIR principles	Data access and reuse, interoperability	Re3data, FAIRSharing, OpenAIRE
Sustainability, Policy Compliance	Data availability and integrity	Re3data, FAIRSharing

The features presented in the first column of the Table 2 represent the attributes of repositories that are identified as most valued by the study authors, as shown below:

- a) Activity and Reputation: The repository must comply with disciplinary community standards, have recognized activity and enjoy a good reputation within the scientific community, and be supported by professional organizations or academic institutions.
- b) Technical support: The repository must provide comprehensive documentation and good technical support to facilitate its use.
- c) Metadata availability: The repository must contain descriptive metadata that provides contextual information about the data, such as the author and purpose of the collection, and the methodology used for its compilation and maintenance. (
- d) Compliance with FAIR principles: The repository must provide clear metadata and support interoperability between different data formats. It must comply with a clear governance structure and transparent policies that enable secure and ethical reuse.
- e) Sustainability and policy compliance: The repository must have a long-term financing model and a plan to ensure its continued operation, and it must include continuity plans to prevent loss of information. The repository must have a solid infrastructure in terms of storage capacity, data security, and backup protocols.

4.1. Discussion

It is important to highlight researchers' openness to publishing data and their appreciation of the benefits this brings to both those who publish and those who access the data. However, current data repositories do not seem to offer a comprehensive solution that meets all the needs of educational researchers.

Despite this limitation, the work presented here provides a comparative evaluation of research data repository catalogs. Based on the obtained findings, FAIRSharing stands out as the tool that offers the best levels of curation and data quality. Its sustainability model and the transparency of its criteria and processes are also noteworthy. FAIRSharing provides an organic view of the publication process and open research infrastructure. However, its exclusive use is not recommended. Because the FAIRSharing database lacks some records, researchers should perform a parallel query in DataCite Commons, and should use re3data to obtain a better view of the validity of certifications.

Given the limitations that hinder visibility, several authors of extant studies in this domain concur that it is necessary to improve the discoverability of available repositories and services, as recently pointed out by Huber, Gonzalez Beltran, Neidiger, Ulrich, and L'Hours et al. (2024). These authors also recognize the need to improve the capacity of repositories and infrastructure to capture diverse disciplinary information. Other researchers, including Ulrich et al. (2024), propose mechanisms for discovering the services and capabilities of each repository, even though this approach still requires standardization efforts on the part of repository managers to be useful. Implementing

such proposals in practice would greatly enhance the quality of the data collected by repository catalogs, making them much more reliable and descriptive.

Some researchers, for instance Vogt et al. (2025), choose to neglect the role of repositories and focus instead on content, proposing the creation of a layer of semantic interoperability that unifies resources from a conciliatory perspective for each discipline, facilitating access by researchers not only to research data but to resources in general. According to these authors, this approach blurs the line that differentiates research articles from research data or even resources external to the research area (e.g., OERs, government data, software, etc.), concepts that are difficult to differentiate for the majority of researchers and that often may not make sense to differentiate from the researcher's point of view.

Other proposed strategies include the use of data management plans (DMPs) to make the dialogue between the different actors during the research process transparent (Bicarregui et al., 2012). Miksa, Mietchen, and Simms (2019) go a step further to suggest capturing the dialogue in a structured and automatically actionable document (maPGD). Although the use of DMPs is not new, their adoption still needs to be increased before they can be fully exploited.

Such initiatives will help bridge the disciplinary gap and promote dialogue between data management and disciplinary knowledge.

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ARTICLE / ARTÍCULO

Professional Training and Digital Competence in Teaching: A Systematic Review of the Literature

Formación Profesional y Competencia Digital Docente: una revisión sistemática de la literatura

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Abstract: This research aims to analyse the scientific evidence regarding the levels of Digital Competence (DC) among Vocational Education and Training (VET) teachers in Spain. To achieve this, a systematic review of the literature is presented as a research design, following the PRISMA-P Statement. The databases consulted were Dialnet, Scopus, and Web of Science, covering the search period from 2014 to 2022. Following the filtering process, 12 studies were selected for further analysis. The results indicate that in the past decade, there has been a notable increase in research aimed at recognising and examining the levels of Digital Competence in Teaching (DCT), as well as its impact on teaching-learning processes. However, there exists a scarcity of published scientific output. It has been concluded that teachers, in general, and Vocational Training teachers, in particular, perceive themselves to be at a low level of development in digital teaching competence. It is essential to implement research instruments that assist them in: (1) identifying their actual level of Digital Teaching Competence, and (2) providing training proposals that enhance the areas constituting Digital Teaching Competence and shape their attitudes towards the use of Digital Technologies.

Keywords: Vocational Education and Training (VET), Educational Technology, Digital Competence of Educators, Systematic review.

Resumen: El propósito de esta investigación es analizar la evidencia científica sobre los niveles de Competencia Digital (CD) que poseen los docentes de Formación Profesional (FP) en España. Para ello se presenta como diseño de investigación una revisión sistemática de la literatura, sustentada en la Declaración PRISMA-P. Las bases de datos consultadas han sido Dialnet, Scopus y Web of Science, y el periodo de búsqueda comprende los años 2014-2022. Tras el proceso de filtrado se han seleccionado 12 estudios. Los resultados demuestran que en la última década ha habido un importante incremento en investigaciones orientadas a reconocer y examinar los niveles de Competencia Digital Docente (CDD), así como su impacto en los procesos de enseñanza-aprendizaje. Sin embargo, existe un número escaso de producciones científicas que se encuentren publicadas. Se ha concluido que el profesorado en general y de Formación Profesional en particular, se percibe a sí mismo en un nivel bajo de desarrollo de la Competencia Digital Docente y es necesario aplicar instrumentos de investigación que les ayuden a: (1) identificar su nivel real de Competencia Digital Docente y, (2) proporcionar propuestas formativas que mejoren las áreas que constituyen la Competencia Digital Docente y determinar sus actitudes hacia el uso de las Tecnologías Digitales.

Palabras clave: Formación Profesional, Tecnología Educativa, Competencia Digital Docente, Revisión Sistemática de la Literatura.

1. Introduction

The consistent integration and quotidian utilisation of Digital Technologies (DT) within educational contexts do not inherently ensure their advantageous outcomes or pedagogical efficacy (Antonietti et al., 2022; Lázaro-Cantabrana et al., 2019). The academic discourse presents a spectrum of viewpoints concerning the evolution of technological infrastructure within educational institutions, frequently juxtaposing this evolution with the pragmatic implementation of such frameworks. Notably, Esteve-Mon et al. (2016) elucidate how the cultivation of Teaching Digital Competence (TDC) bolsters the utilisation of technology-enhanced learning environments. Furthermore, Verdú-Pina et al. (2023) emphasise the critical importance of advancing technopedagogical and methodological paradigms related to digital technology (DT) within classrooms that are oriented towards technology integration. These findings collectively underscore the prevailing emphasis within the literature on the imperative of ongoing professional development for educators.

Enterprises and governments are increasingly focused on facilitating the integration and sustainability of DT within educational processes to enhance the labour market by producing highly qualified personnel (Otero Gutiérrez et al., 2018). In the Spanish context, a crucial strategy for addressing workforce improvement is the coaching of Vocational Education and Training (VET) students. VET is defined as the "set of training processes aimed at preparing individuals for the workforce and ensuring their qualifications" (Campos-Bermejo & Morales-Lozano, 2022, p. 88). Numerous modifications have been implemented to align VET with the needs of the productive sector. Given its nature, VET serves as the most relevant educational level for building the foundation of professional citizenship. However, data indicate that significant progress is still needed to accomplish this goal (Jalil, 2018).

In recent years, educational policymakers have initiated a paradigm shift aimed at reconfiguring VET classrooms into environments where the utilisation of DT is fundamentally integrated. The primary objective of this transformation is to equip VET students with a nuanced understanding of market dynamics, thereby enhancing their capacity to devise and implement innovative projects and proposals for organisational improvement (Ministerio de Educación y Formación Profesional, 2020). Achieving this ambitious vision requires VET educators not only to recognise and articulate their roles as digitally competent stakeholders but also to engage in the practical application of appropriate pedagogical methodologies and the seamless integration of digital technologies into the educational framework (Campos-Bermejo & Morales-Lozano, 2022).

1.1. Vocational Education and Training and Teaching Digital Competence.

Vocational Education and Training (VET) serves as a pivotal mechanism for facilitating the transition toward a society capable of autonomously navigating complex technical environments. It establishes a critical connection between theoretical instruction and practical application within the professional sphere (Borden et al., 2023). Furthermore, VET institutions emulate the operational dynamics of corporate entities by incorporating DT into their pedagogical frameworks (Schwendimann et al., 2015; Redecker, 2017). For instance, educators within VET programs strive to adapt their technical and pedagogical knowledge to ensure that students not only comprehend

the theoretical underpinnings of their education but also effectively apply that knowledge in practical skills in real-world contexts (Cattaneo and Aprea, 2018).

In the scholarly discussion surrounding TDC, Lázaro Cantabrana et al. (2019) explain that a foundational principle involves integrating DT after acquiring a comprehensive repertoire of competencies, abilities, and skills. The extent of TDC attainment is theorised to significantly influence educators' methodologies in engaging with environmental phenomena and scientific concepts, fostering approaches that are both diverse and innovative (Lund et al., 2014). Furthermore, individual educators may enhance their capability to evaluate the intricate interrelations between content, pedagogy, and technology, particularly after completing a reflective understanding of their personal TDC levels (Instefjord & Munthe, 2017).

1.2. Applied Technology Classroom Concept in Vocational Education and Training.

In 2012, a notable emergence of environments characterised by a high presence of DT occurred, exemplified by the establishment of Future Labs and Entrepreneurship Classrooms throughout Europe, including Spain (INTEF, 2017). This was a strategic response to the evolving landscape of VET. Subsequently, in 2020, the Applied Technology Classroom (ATC) was introduced as a key initiative aimed at modernising VET for a new era and responding to the COVID-19 economic crisis. These cutting-edge technological spaces have been meticulously designed to equip the emerging workforce in Spain with essential skills, thereby fostering a culture centred on digitalisation, innovation, and entrepreneurship (San-Martin et al. 2020). As the educational system progressively integrates these advancements, it better prepares students to thrive in an increasingly competitive and dynamic job market (Moreno-Guerrero et al., 2021).

The primary objective of ATC initiatives is to transform VET, enhancing digital competencies and reinforcing core elements such as collaboration, active participation, innovative pedagogical techniques, and practical application (Eizagirre Sagardia et al., 2017). This advancement presents a significant opportunity for VET centres to effectively redesign their digital projects, enabling the creation of specialised ecosystems that harness the potential of digital technologies. Ultimately, such transformations are expected to enrich the learning experiences and outcomes for students, equipping them with the necessary skills to navigate the challenges of the modern workforce. (Ministerio de Educación y Formación Profesional, 2020).

1.3. Pedagogical Emphasis on Digital Technologies in VET Centres.

The concept of Digital Technology (DT) in educational settings, as articulated by Loogma et al. (2012), serves as a comprehensive construct of digital literacy that underpins various dimensions of the teaching and learning process. This multifaceted approach provides essential support, reinforcement, and enhancements to educational efficacy. The authors further assert that the integration of DT is pivotal not only in bolstering employability but also in fostering active citizenship, promoting social mobility, and conferring competitive advantages at the national level. However, it is imperative to recognise that the prevalent interpretation of DT within educational environments often manifests as a reductive assemblage of technological tools

confined to specific physical spaces. This limited perspective ultimately undermines the foundational intent of technological environments, which were initially conceived to facilitate continuous access to a diverse array of resources through the strategic implementation of digital technologies (Brown & Long, 2014).

To advance the establishment of ATC within VET centres, the focus must extend beyond infrastructural considerations and equipment procurement. It should concentrate on implementing pedagogical methodologies that effectively facilitate the acquisition of complex technical competencies. As Tena and Carrera (2020) elucidate, these innovative educational environments should equip students with the necessary tools "to enhance their digital competencies and cultivate their social skills" (p. 466). From an instructional standpoint, the integration of technology within ATC is suggested to have a profoundly positive influence on students' engagement in active exploratory learning, due to the synergistic alignment between technological resources and the selected pedagogical frameworks (King et al., 2015).

The relationship between TDC and VET is a complex one that deserves further exploration, as existing literature often overlooks significant evidence that could enhance our understanding of this interplay. To address this deficiency, the primary objective of this article is to analyse the scientific evidence regarding the levels of TDC possessed by VET teachers and their engagement with ATC spaces in Spain. To facilitate this analysis, several key research questions have been established:

- What scientific evidence does exist about VET teachers' Digital Competence?
- Related to Digital Competence, what training needs do VET teachers have?
- Regarding VET Learning regulated by the inclusion of DT, what modality (In-person, hybrid, distance) and what type of methodologies are more efficient for VET student learning?
- Concerning DC, what role should the VET teacher play in the management of an ATC?

Through the rigorous examination of these pivotal inquiries, the article aims to provide substantive insights into the integration of technology within vocational education, as well as the ongoing professional development of educators in this field.

2. Methodology

A systematic literature review (SLR) was conducted to thoroughly examine the existing scientific evidence regarding the levels of DC exhibited by VET instructors, as well as the application of technological frameworks within the Spanish context. The execution of a systematic literature review required adherence to a pre-established search protocol, which encompasses stringent inclusion and exclusion criteria to ensure methodological rigour. This research endeavour was grounded in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocol (PRISMA-P) guidelines, as outlined by Moher et al. (2015) and Shamseer et al. (2015). The PRISMA-P guidelines were instrumental in articulating the processes of identification, screening, eligibility assessment, and criteria for inclusion (refer to Figure 1) of the pertinent

publications. These processes subsequently informed the development of the results, discourse, and conclusions articulated within this systematic literature review.

3. Study search strategy

The following outlines the sequence of terms utilised in the search conducted in key high-quality database sources pertinent to this research topic: Dialnet, Scopus, and Web of Science (refer to Table 1). The search incorporated terms related to vocational education and training (VET) as well as the Digital Competence of teachers, employing the Boolean operators “AND” (formación AND profesional) and (vocational AND training) and “OR” (competencia digital OR literacy). The search was filtered by language, specifically in English and Spanish. Given the limited number of publications on VET and TDC, some terms were not indexed in Scopus and Web of Science. For instance, the phrase “digital competence” was excluded, and the time range and geographic focus varied.

Table 1. Terms used for the bibliographic search, according to databases.

Database	Search	Period
Dialnet	(Formación Profesional Dual) (formación profesional) AND (competencia digital OR literacy) Languages: English and Spanish	2014- 2022
Scopus	(formación AND profesional) AND (vocational AND training) refinado: 2016-2022, vocational Training, Languages: English and Spanish	
Web of science	vocational training (Topic) and Open Access and 2022 or 2021 or 2020 or 2019 or 2018 (años de publicación) and SPAIN (país/regiones)	

3.1. Inclusion and Exclusion Criteria

Table 2 outlines the inclusion and exclusion criteria applied throughout the phases of the systematic literature review (SLR), including identification, screening, eligibility assessment, and final inclusion. This review focuses on literature published between January 2014 and December 2022, a period marked by significant developments in vocational education and training, as well as in the pedagogy of DC. Prior to this timeframe, research in these areas was notably scarce, highlighting a significant gap in scholarly discourse.

The criteria presented in Table 2 serve to ensure that the literature selected for review is both relevant and of high scholarly quality, facilitating a thorough examination of pedagogical advancements and emerging frameworks. This systematic approach aims to contribute to a deeper understanding of current practices in Digital Competence within vocational education, contextualising these developments within the broader landscape of educational research and policy, considering the rapid technological advancements.

Table 2. Inclusion and exclusion criteria used for the systematic literature review

Inclusion Criteria	Exclusion Criteria
IC1: Publications that show qualitative and quantitative results on the levels of Digital Competence (DC) of teachers and students of Vocational Education and Training (VET) were considered, as well as the pedagogical usage they make of the Applied Technology Classrooms (ATC) and/or methodologies related to DT and digitization of VET centers.	EC1: The publication was considered out of context. Publications that are not aimed at Vocational Education and Training and Digital Competence are not included, and future VET teachers are not considered.
IC2: International, European, and studies in Spain that evaluate the DC level of VET teachers and other experiences of using applied technology classrooms, entrepreneurship or also known as Future Classrooms Labs.	EC2: Publications that are not carried out at the VET educational level, whether traditional or dual, have been excluded.
IC3: Descriptive, experimental studies, case studies, triangulation of qualitative and quantitative data or bibliometric studies.	EC3: Studies with deficits in the presentation of the study methodology or lack of information on the study design have been excluded.
IC4: Studies written in English and Spanish published in the period of 2014 to 2022, only in scientific journals.	EC4: Studies published before 2014.
IC5: Complete scientific articles with open access were considered.	CE5: Those articles that were not available in the databases have not been included.

3.2. Conducting the review

As articulated in the introductory section, the research endeavour was formally initiated after a comprehensive consensus among the authors regarding several foundational elements. Specifically, the authors delineated (1) the core research questions, which served as the guiding framework for extracting pertinent answers from a meticulous analysis of the selected publications, (2) the systematic search strategies employed in strict adherence to the PRISMA-P (Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols) statement, thereby ensuring methodological rigor and transparency throughout the research process, and (3) the explicit criteria established for the inclusion and exclusion of publications, which were pivotal in curating a relevant and high-quality body of literature for review.

Figure 1 graphically represents the various phases as outlined in the PRISMA-P declaration, thereby providing a visual representation of the structured approach employed in this systematic review. This methodological framework not only strengthened the integrity of the research but also facilitated a comprehensive synthesis of existing knowledge within the identified domain of inquiry.

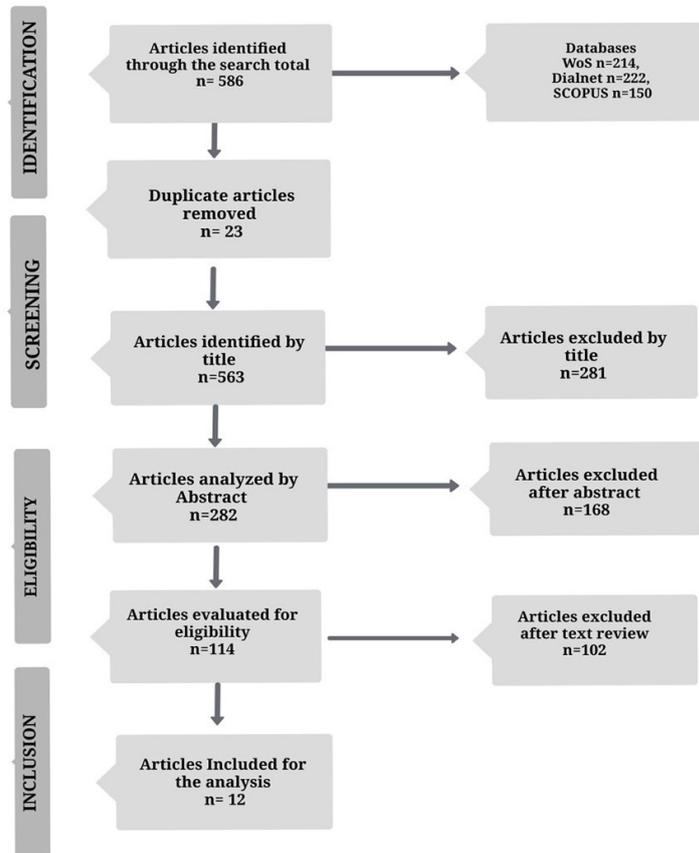


Figure 1. Description of the Systematic Literature Review procedure, based on the PRISMA Protocol.

3.3. Identification phase

In December 2022, a comprehensive literature review was conducted, resulting in the retrieval of a total of 586 scholarly publications from various academic databases, specifically Dialnet (46%), Scopus (23%), and Web of Science (31%). The selection criteria for these publications directed the inclusion of both qualitative and quantitative findings regarding the levels of DC among Vocational Education and Training (VET) teachers and students. Additionally, the review encompassed publications that explored the pedagogical applications of Applied Technology Classrooms, thereby fostering a richer understanding of teaching methodologies within this context.

To systematically organise and facilitate further analysis, relevant references and information from the retrieved publications were catalogued in a Microsoft Excel spreadsheet. This technical framework included critical data such as the title, abstract, authorship, year of publication, specific objectives, and delineated learning outcomes for each study. Through this rigorous process, 23 duplicates were systematically identified and removed, resulting in a refined selection of 563 publications deemed relevant for subsequent phases of review and analysis. This meticulous approach

underscores the commitment to ensuring a comprehensive and academically rigorous foundation for the following examination of DC within the VET sector.

3.4. Screening phase

During this phase of the systematic review process, an assessment of the literature was conducted, focusing on the titles of the publications to determine their relevance to the established exclusion criteria. Initially, a comprehensive database search yielded a substantial number of publications. However, upon scrutiny by the researchers, it became apparent that a significant portion did not meet the stringent criteria set forth for inclusion in the study. As a result of this rigorous filtering process, a total of 281 publications were systematically excluded because they failed to satisfy one or more of the predetermined exclusion criteria. These criteria were designed to ensure that only the most relevant and high-quality studies would be considered for further analysis.

Following this thorough evaluation, 282 publications emerged as suitable candidates for progression to the next phase of the review. This selection marks a critical step in the research process, as the chosen publications will undergo a more in-depth examination to assess their methodologies, findings, and contributions to the field. This phase ensures that the foundation of the subsequent analysis is built upon a solid framework of relevant and credible literature.

3.5. Eligibility phase

During the eligibility phase, a comprehensive analysis was conducted of the 282 submitted abstracts. This critical evaluation led to the exclusion of 168 abstracts, based on stringent adherence to predefined inclusion and exclusion criteria. The primary rationale for exclusion centred around the absence of pertinent discussions regarding the DC of Vocational Education and Training (VET) teachers (denoted as EC1). Additionally, many abstracts failed to provide substantial insights into the utilisation or application of methodologies associated with digital technologies (DT) or the integration of digitisation within VET classroom settings (IC1). Following this rigorous screening process, a total of 114 publications were meticulously selected for the final phase of the review, ensuring a robust and focused examination of the relevant literature in this vital area of educational research.

3.6. Inclusion phase

Throughout the inclusion phase, a comprehensive examination was conducted on a total of 114 publications. Pre-established inclusion and exclusion criteria were meticulously reviewed in each publication to ensure the integrity and relevance of selected studies. Out of the 114 publications, 102 were excluded based on their failure to meet specific inclusion criteria, which were systematically categorised as follows: Inclusion Criterion 1 (IC1) accounted for 42 exclusions, Inclusion Criterion 2 (IC2) led to 10 exclusions, Inclusion Criterion 3 (IC3) resulted in 12 exclusions, Inclusion Criterion 4 (IC4) prompted 8 exclusions, and Inclusion Criterion 5 (IC5) culminated in 30 exclusions.

Ultimately, a selection of 12 publications was identified and incorporated into a rigorous and methodologically sound analysis. This selection process was meticulously designed to enhance the clarity, consistency, and reliability of the research objectives. The chosen publications aim to provide scientific insights and

substantive answers to the core research questions, thereby contributing to the advancement of knowledge within the relevant field.

4. Results

4.1. Characteristics of the included articles

The selected publications, which adhered strictly to the predefined inclusion criteria, comprise a total of 12 studies, as detailed in Table 1. These works represent a diverse range of research methodologies, reflecting a comprehensive approach to the investigated phenomena. Specifically, the body of literature includes four quantitative studies that employ statistical analyses to derive significant findings; three descriptive-correlational-predictive studies that elucidate relationships among variables and forecast outcomes; one quasi-experimental study that offers insights into causal inferences within a controlled setting; one bibliometric analysis that systematically evaluates the impact and contributions of literature in the field; and finally, three qualitative studies which provide depth and context through rich, narrative data. This variation in research design, illustrated in Figure 2, underscores the multifaceted nature of the inquiry and the breadth of perspectives represented in the literature.

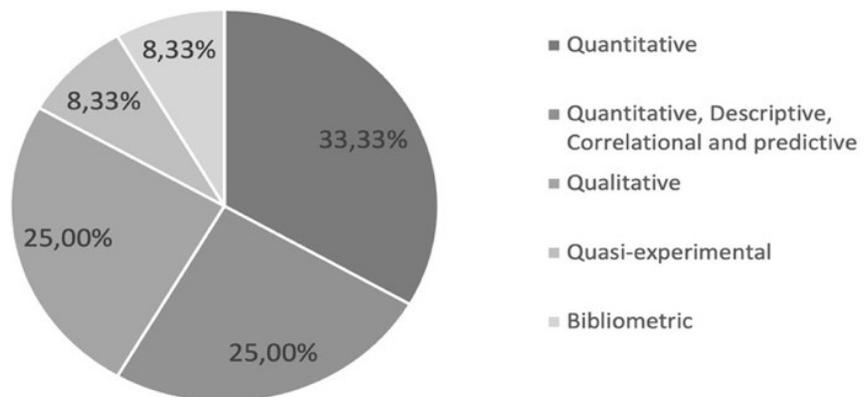


Figure 2. Study Types included for the SLR.

The studies included in this systematic literature review (SLR) share a common thematic focus on examining TDC within the VET context. Moreover, these studies explore the innovative development of educational environments and learning spaces where Digital Technologies (DT) are actively integrated and utilised as pedagogical tools. The synthesis of findings across these investigations underscores the multifaceted role of DT in enhancing instructional methodologies, fostering skill acquisition, and ultimately transforming the educational landscape within vocational training programmes. A comprehensive overview of these studies is presented in Table 3, highlighting the distinct objectives and contributions of each research endeavour to the broader discourse on TDC in vocational education and training (VET). Through this

aggregation of literature, the review aims to explain the pathways through which DT not only facilitates learning but also propels systemic changes within vocational educational frameworks.

Table 3. Description of included articles for the SLR

Reference	Type of study	Objective	Main results
Sánchez-Prieto et al., 2021	Quantitative	Find out if the inadequate DTC development also occurs in the Dual VET.	With a sample of 1,568 VET teachers, the results show that due to a low level of digital skills, it is improbable to find the factors that influence various DC components, such as the teacher's previous knowledge, where the educational center is located, or the professional family to which it belongs.
Casal Otero et al., 2021	Quantitative	To know the DTC levels of VET teachers in Galicia, their attitudes towards DT and the influence of the gender variable in this competence.	The results describe that the sample of 249 teachers has an integrator and expert DTC level, attitudes towards DT are favourable and the gender variable is a significant factor in the DC levels in VET teachers.
Sánchez Prieto et al., 2020	Quantitative	To determine if the low DC level is influenced by the gender of the teacher.	The sample of this study was 1568 teachers, the results show that there are no significant differences between teachers in the application of skills. It also shows that the gender gap exists in other contexts.
Moreno Guerrero et al., 2020a	Quantitative	To know the level of influence that context, culture, and economic factors have on the use of DT devices, especially computers, tablets, and smartphones.	With a sample of 251 students from different vocational education and training families, this study concluded that the context variable does not represent an influence on the frequency of use of the devices analysed or on the training of the students.
López Belmonte et al., 2020	Quantitative Descriptive, correlational, and predictive	To consider how VET teachers make transformative proposals with DT tools such as Augmented Reality and know which are the DTC areas with the highest incidence as a decisive factor for the DT use.	The results obtained from a sample of 627 VET teachers show that the unsatisfactory training of teachers in knowledge about AR does not allow them to develop activities with a high educational content. This scant VET teachers training has an impact on the DTC level. According to the study, VET teachers self-perceived themselves at a medium level of the DTC.

Reference	Type of study	Objective	Main results
Moreno-Guerrero et al., 2021	Quantitative Descriptive, correlational, and predictive	To evaluate and analyse how the DC of VET teachers interferes when dealing with teaching processes throughout virtuality.	With a sample of 627 VET teachers, the results of this study reveal the scarcities in the different DTC areas. According to the authors, the results reflect how these scarcities directly affect the teaching processes throughout virtuality. The findings of this research also reveal that two of the DTC areas (Areas 1 and 2) restrict VET teachers' usage of the online learning model.
López-Belmonte et al., 2020	Quantitative Descriptive, correlational, and predictive	To know VET teachers DTC average in the application and development of the Blended Learning method.	According to the findings obtained after the participation of 627 VET teachers, it was possible to identify that the lack of VET teachers DTC development limits the development of models such as Blended Learning, and that the DTC is a key stone for the development or application of models like this or similar ones.
Hinojo-Lucena et al., 2020	Quasi-experimental	Find out the degree of effectiveness of the B-learning modality at the Vocational Education and Training educational level, with emphasis on an applied sciences module.	With a sample of 147 VET students, this study models how students who have developed tasks through the Blended Learning modality have obtained improvements in all dimensions of the study.
Moreno Guerrero, Antonio José (2019)	Bibliometric	To know the publications that develop the B-learning modality in Vocational Education and Training, the data was obtained from the high-quality Web of Science database.	The results show that there is an increasing interest in scientific production on this subject, this conclusion could be obtained after a finding of 63 publications included for the analysis.
Lorente García, Rocío (2014)	Qualitative	To analyse the perception of teachers about the improvements that must be made to the VET to meet the demands of the labour market.	With the participation of 50 teachers, it was possible to extract their perception based on the necessary and pertinent improvements to the VET educational system. As a result, it was possible to assess the need to improve the technification of the VET processes but focused on the attention of a constantly changing labour market.

Reference	Type of study	Objective	Main results
García-de-Paz & Santana Bonilla, 2021	Qualitative	To inquire from the perspective of VET teachers, the virtual training, and transformative processes, embraced after the COVID-19 pandemic arrival.	Interviews were conducted with a sample of 8 members of the teaching management staff of a Vocational Education and Training centre with an emphasis on Electricity and Electronics. The findings suggest three elements that helped the transition from face-to-face to virtual education; the basic digital services for communication and teaching that the centre has, the organizational structure of the centre based on a shared leadership model with an autonomous team and the participation of the family as a fundamental pillar from the perspective of teachers.
Suárez Guerrero et al., 2021	Qualitative	To relate pedagogy, resources, evaluation as an essential mean in the VET teachers DTC acquaintance.	Based on a sample of 11 teachers from the Autonomous Community of Valencia. Several conclusions were obtained, highlighting among the main ones, the wisdom of teachers about some of the technological resources and the adaptability to the teaching practice. However, the study also valued that teachers do not use technological tools in the evaluation processes.

The analysis reveals a significant increase in the volume of scholarly literature dedicated to exploring and analysing the impacts of TDC on pedagogical methodologies and educational frameworks over the past eight years. This trend is further corroborated by an examination of its association with VET and the broader scope of lifelong learning initiatives (refer to Figure 3) (Aguilar de la Rosa, 2022). Despite this positive trajectory, it is essential to highlight the prevailing deficiency of publications indexed in high-quality, peer-reviewed databases. Such a shortfall hampers the potential for comprehensive and rigorous scientific inquiries into this critical domain, thereby limiting the depth of understanding and the advancement of knowledge about TDC's multifaceted influences in educational contexts.

4.2. Relation between the SLR findings and other studies discussing TDC

Several of the included studies explore concepts based on the perceptions and discourses of VET teachers regarding the current state of vocational education and its significance in society. Conversely, other studies focus on a labour market characterised by pressing demands and a strong emphasis on developing workers' digital competencies (Lorente García, 2014). These publications identify teachers as a crucial source of knowledge, vital for shaping a country's future workforce. The data suggest that VET teachers must effectively differentiate between the content taught in the classroom and that which is applied and tested in real-world practice (Aguilar González, 2015; Barrientos et al., 2019). Homs Ferret (2016) argues that, given the continuous expansion and influence of new digital technologies, the role of VET teachers has evolved beyond that of a passive participant in their learners' knowledge

development. For instance, concerning learning acquisition, teachers are now expected to act as mediators between what occurs in educational settings and what is required in the workplace.

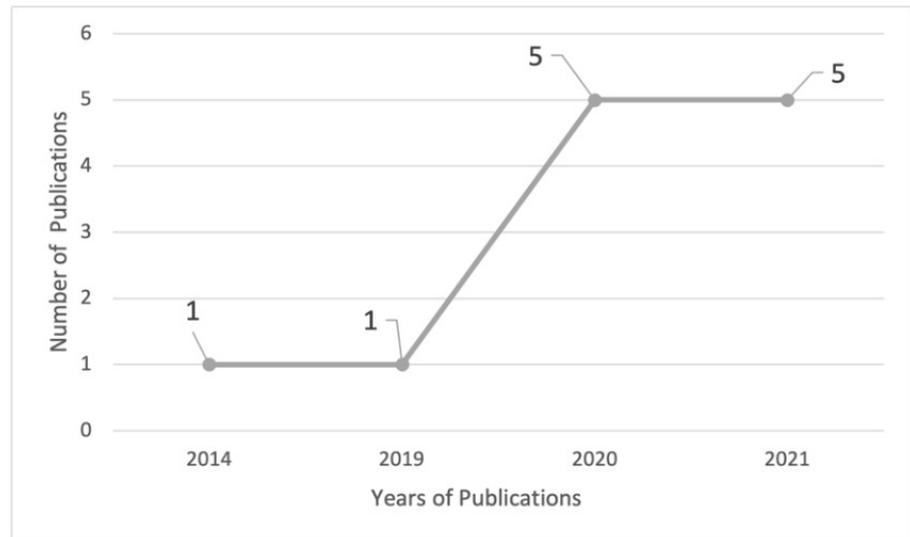


Figure 3. Description by year of the included publications for the SLR

In their study, García-de-Paz and Santana Bonilla (2021) investigate how teachers assess their DC and its impact on the development of students' digital skills. They emphasise that the integration of digital technologies (DT) profoundly influences teaching methodologies and learning processes, which are crucial for achieving optimal levels of TDC. The works of Cabanillas-García et al. (2019), López Belmonte et al. (2020a), and Moreno Guerrero et al. (2020a; 2021), along with Suárez Guerrero et al. (2021), support the argument that effective digital integration is essential for fostering digital competencies in both educators and students, thereby enhancing educational outcomes in contemporary contexts.

Casal Otero et al. (2021) conducted a comprehensive investigation into the concept of TDC, positioning it as a pivotal element in enhancing pedagogical practices within VET. Their analysis highlights the importance of both didactic methodologies and the attitudinal dispositions necessary for the effective integration of Digital Technology (DT) within educational contexts. Concurrently, the works of Sánchez Prieto et al. (2020) and Sánchez-Prieto et al. (2021) delineate the gender disparity among VET educators as a salient factor influencing the sustainable development of TDC. In contemporary discourse, the gender gap emerges as a critical theme impacting TDC advancement across various strata of Vocational Education and Training (Mosteiro García & Porto Castro, 2016; Sanmartín López et al., 2016; Villar-Aguilés & Obiol-Francés, 2020) and extends its implications across diverse educational tiers (Hidalgo Ariza et al., 2020; Niño-Cortés et al., 2022; Usart-Rodríguez et al., 2021).

The existing literature critiques the efficacy of TDC within VET centres (García-Valcárcel et al., 2017; Lázaro Cantabrana & Gisbert Cervera, 2015), thereby underscoring the need to recalibrate training paradigms for future VET educators. This imperative is

substantiated by extensive discourse in various studies involving both undergraduate and master's degree candidates that advocate for further scholarly exploration into the acquisition of Digital Competence (DC) as an essential cross-curricular competence (Casal Otero et al., 2022; Cisneros-Barahona et al., 2022; Esteve-Mon & Gisbert, 2013). Such investigations are crucial for refining pedagogical strategies and ensuring the alignment of educational outcomes with contemporary technological needs.

Numerous scholars, including Hinojo-Lucena et al. (2020), López-Belmonte et al. (2020b), and Moreno Guerrero (2019), have conducted thorough examinations regarding the impact of TDC on the evolution of pedagogical methodologies, particularly blended learning. These studies provide a comprehensive overview of how vocational education and training (VET) instructors self-assess their competencies when employing strategies designed to enhance the educational experience of VET students. Key variables identified within this body of research—such as the specific domains of TDC, spatial reconfiguration, and gender considerations—shed light on the factors influencing the self-perceived levels of TDC among VET educators. In this context, Moreno-Guerrero et al. (2020b) undertake an in-depth analysis of TDC domains alongside information literacy and its constituent dimensions. Concurrently, Gómez-García et al. (2022) elucidate the principles of spatial redesign and transformation within educational institutions as informed by the “Future Classroom Lab project,” emphasising how such spatial innovations enhance collaborative endeavours between students and educators.

5. Conclusions

In this segment, a systematic organisation and comprehensive analysis of each research question is presented, grounded in the findings derived from the publications included in the systematic literature review (SLR).

5.1. What scientific evidence exists about VET teachers' Digital Competence?

The current landscape of VET highlights a significant deficiency in high-quality evidence regarding the DC of VET teachers. This concern has prompted increased scrutiny and emphasis from scholars in the field. Moreno-Guerrero et al. (2020a) assert that the inadequate training of educators in the pedagogical application of digital technologies (DT) can largely be attributed to an overemphasis on the instrumentalisation of Digital Competence. Their findings suggest that educators who recognise their DC levels are more likely to enhance educational quality and implement methodologies that are aligned with the ongoing digital transformation.

Further supporting this perspective, García-Valcárcel et al. (2017) contend that the effective pedagogical implementation of emerging digital technologies—such as augmented and virtual reality—necessitates a robust development of DC among educators. This sentiment is echoed by Suárez Guerrero et al. (2021), who argue that DC for VET teachers should not merely be an ancillary skill but rather a cross-curricular priority integral to the qualification process of VET students.

Moreover, Cabanillas-García et al. (2019) elaborate on the critical role that DC plays in facilitating effective teaching and learning processes across various modalities. They posit that digital technologies can serve as essential tools for instructional

delivery within the VET framework. Collectively, these insights underscore the imperative for educational institutions to prioritise the development of DC among vocational education and training (VET) teachers to foster a more effective and relevant educational experience for their students.

5.2. Concerning Digital Competence, what training needs do VET teachers have?

The integration of DT within educational environments is experiencing a significant rise across various levels of the educational system. According to the comprehensive analysis conducted by Moreno-Guerrero et al. (2021), this trend underscores the need for educators to develop a nuanced understanding of digital transformation. As classrooms increasingly reflect the demands and expectations of a technologically know-how student body, it becomes essential for teachers to not only familiarise themselves with these tools but also to harness them effectively in their pedagogical practices. This journey entails developing a robust DC that empowers educators to adeptly manage various technological resources and create innovative teaching methodologies that seamlessly incorporate these tools.

Furthermore, López Belmonte et al. (2020b) highlight that the rapid progression of technological innovation has brought to the forefront certain limitations that educators, as users of DT, demonstrate. These deficiencies are not merely technical but extend to a broader self-perception regarding their TDC. As teachers grapple with the demands of integrating technology into their pedagogical frameworks, their often low self-assessment of their abilities can inhibit effective implementation. This situation underscores the pressing need for targeted professional development initiatives that enhance teachers' confidence and competence in utilising digital technologies within the classroom context. The evolving landscape of education requires a paradigm shift in how teachers perceive and implement their roles in integrating digital technologies. By addressing both the knowledge requirements and the psychological barriers surrounding TDC, the educational system can move toward a more integrated and effective use of technology that enriches students' learning experiences.

5.3. Regarding VET Learning regulated by the inclusion of DT, what modality (In-person, hybrid, distance) and what type of methodologies are more efficient for VET student learning?

Blended learning, often referred to as hybrid learning, has garnered significant acceptance in the realm of vocational education and training (VET) due to its potential to enhance instructional effectiveness. López-Belmonte et al. (2020b) elucidate that the integration of blended learning merges traditional pedagogical methods with innovative technological tools, thereby allowing educators to refine their instructional strategies. However, the authors caution that the full realisation of blended learning's benefits may be hindered by certain limitations in its implementation, suggesting that these shortcomings deserve careful consideration to optimise the teaching and learning experience.

Furthermore, Sánchez Prieto et al. (2020) emphasise the critical linkage between the methodologies associated with digital technologies (DT) and their didactic applications. The authors argue that the effective integration of these technologies is vital for professional development within the educational sector. García-de-Paz and Santana-Bonilla (2021) elaborate on this context by addressing the

transformative impact of the COVID-19 pandemic, which necessitated a rapid transition from traditional face-to-face instruction to remote or virtual learning environments due to the unprecedented lockdown measures.

This shift has presented educators with a dual-faceted challenge. On the one hand, some perceive this transition as an invaluable opportunity to modernise their pedagogical approaches and enhance the quality of the teaching-learning process. Such educators are inclined to embrace innovation and seek ways to leverage technology to foster more engaging and compelling learning experiences. Conversely, some resist these changes, viewing them as disruptive to their established teaching practices and routines. This dichotomy highlights the ongoing tension within the educational community regarding the adoption of new methodologies. It underscores the imperative for professional development and support systems to facilitate effective transition and foster a culture of adaptability in VET settings.

5.4. Concerning Digital Competence, what role should the VET teacher play in managing an applied technology classroom?

The contemporary educational landscape, as elucidated by Sánchez-Prieto et al. (2021), underscores the multifaceted role of the teacher when guiding students through learning processes within applied technology environments. In this context, the educator emerges as a tutor, moderator, and counsellor, essential for facilitating effective pedagogical interactions. This evolution reflects a significant shift in classroom dynamics, as articulated by Gómez-García et al. (2022). Today's educational spaces have transcended traditional paradigms characterised by static and unengaging methodologies. Instead, they now embody a more dynamic and interactive essence that fosters collaborative technological engagement among teachers and students alike.

The contributions of Hinojo-Lucena et al. (2020) and Moreno-Guerrero et al. (2020b) further illuminate the integral role of digital technology in educational settings. These scholars argue that technology acts as a pivotal support system in the teaching and learning processes, particularly in equipping students to meet the demands of a rapidly evolving labour market. As such, the integration of digital tools not only enhances the learning experience but also provides students with essential resources, motivation, and growth opportunities. This, in turn, cultivates critical skills and promotes greater autonomy in educational pathways.

The intersection of modern educational practices and digital technology heralds a transformative approach to teaching and learning. By embracing collaborative methodologies and situating technology as a supportive ally, educators can better prepare students to navigate the complexities of the contemporary workforce while fostering an engaging and responsive learning environment.

5.5. Conclusive Insights Derived from the Systematic Literature Review

This systematic literature review analyses the empirical evidence regarding the levels of DC among VET educators and their interactions with applied technological environments within the Spanish context. In strict adherence to the PRISMA-P guidelines, rigorous inclusion criteria have been established, ensuring that the

methodological approach yields reliable and valid responses to the research questions posed.

The outcomes of this review reveal a troubling dearth of scholarly contributions that thoroughly investigate the Technological Digital Competence (TDC) of VET instructors, particularly within esteemed and high-quality academic databases. This notable gap in the literature highlights a significant limitation in the existing body of knowledge, underscoring the need for bibliographic studies to illuminate key aspects of TDC. Consequently, the findings emphasise the need for expanded research initiatives that can comprehensively address the digital pedagogical readiness of VET teachers, thereby fostering a deeper understanding of the competencies required in an increasingly digital educational landscape.

The analysis conducted on the studies included in this investigation highlighted the critical significance of developing TDC among VET educators. This topic emerges as a pivotal concern not only for educational policymakers tasked with shaping effective curricula and professional development programs but also for employers who rely on the VET system to produce highly competent graduates equipped to meet the demands of the contemporary workforce.

The inquiry yielded compelling evidence of a persistent trend: VET educators frequently exhibit a low self-assessment of their DC. This phenomenon can be comprehensively attributed to two primary factors. Firstly, the existing training frameworks regarding the components of TDC often prove inadequate, failing to equip educators with the necessary skills and confidence to integrate technological tools into their pedagogical practices effectively. Secondly, prevailing attitudes towards digital transformation play a crucial role, as these attitudes significantly influence educators' engagement with technological resources and their application within educational settings. Such dynamics underscore the urgent need for strategic interventions that enhance the digital competencies of VET educators, thereby fostering a more robust and effective vocational education ecosystem. This study represents a pivotal contribution to the academic discourse surrounding VET educators and their digital competencies. By implementing a structured scientific protocol in our analysis, we affirm the validity of our findings.

Moreover, this study offers a systematic examination of TDC levels among VET teachers, with our conclusions emphasising the pressing need for the development of research instruments that enable educators to assess their actual TDC level accurately. The implications of this research extend beyond academia, serving as a valuable resource for all stakeholders involved in the VET sector, facilitating optimised resource allocation, and enhancing awareness of digital competencies.

5.6. Limitations of the study

Throughout this study, several significant limitations have been encountered that warrant discussion. Foremost among these was the limited number of publications focusing on the pedagogical applications of digital technologies within Vocational Education and Training (VET) settings. This scarcity of relevant literature highlights a notable gap in the research landscape, complicating efforts to draw comprehensive conclusions about the integration of digital tools in educational practices. Additionally, issues have arisen with the methodological rigour and clarity of the existing studies.

Many of the publications reviewed lacked coherent frameworks or robust methodological structures, raising concerns about the reliability and generalisability of their findings. Such deficiencies prompt questions about the validity of the conclusions drawn and underscore an urgent need for more systematic and transparent research approaches in this domain. Moreover, the constraints imposed by the study's timeline limited the ability to conduct a thorough review. This factor emphasises the necessity for ongoing grants that can adapt to the rapidly evolving technological landscape and its implications for VET.

5.7. Implications for Future Research Endeavours

This study highlights the necessity for a broader framework to understand TDC in VET. By utilising various high-quality databases, including ERIC, researchers can obtain comprehensive insights into the integration of digital skills within vocational curricula. An interdisciplinary approach, drawing from educational technology, pedagogy, psychology, and workforce development, facilitates the identification of best practices in teaching and informs policy formulation.

Using diverse methodologies, researchers can uncover the barriers and facilitators that affect the implementation of digital competency frameworks. This general perspective is vital for developing targeted, evidence-based pedagogical strategies for vocational learners. Ultimately, this inclusive approach enhances academic discourse on DC and supports the creation of policies that prepare students for success in a digital workforce.

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ARTICLE / ARTÍCULO

Immersive learning ecosystems: The synergy of ChatGPT and metaverse in a higher education institute of technology in Ecuador

Ecosistemas de aprendizaje inmersivo: sinergia ChatGPT y metaverso en Institutos Superiores Tecnológicos del Ecuador

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Abstract: This study explores the challenges and benefits of integrating ChatGPT and the metaverse at a higher education institute of technology in Ecuador, with an emphasis on two barriers—the digital divide and lack of training—that limit access to and the effectiveness of innovative teaching methods. Using a qualitative methodology, data was collected through semi-structured interviews, demonstration classes, and structured observation by involving 12 students and 3 professors. During the practical activities, participants shared their perceptions and experiences. The findings highlight that the metaverse facilitates the understanding of complex concepts and encourages collaboration in simulated environments, while ChatGPT promotes autonomy and personalization in learning. The use of ChatGPT to solve basic queries also reduced the teaching load and allowed professors to focus on facilitation and evaluation of student performance. However, challenges such as limited connectivity, inadequate equipment, and lack of prior experience hindered initial implementation. The participants emphasized that pedagogical guidelines were helpful in structuring the use of these tools. The study concludes that the synergy between ChatGPT and metaverse can transform higher education. However, it is necessary to provide specialized training and have inclusive policies to ensure equity and effectiveness in students' access to these emerging technologies.

Keywords: Generative Artificial Intelligence, ChatGPT, Metaverse, Higher Education, Case Study.

Resumen: La investigación explora los desafíos y beneficios de integrar ChatGPT y el metaverso en Institutos Superiores Tecnológicos en Ecuador, con énfasis en la brecha digital y la falta de capacitación en estas tecnologías. Estas barreras limitan el acceso y la eficacia de métodos innovadores de enseñanza. A través de una metodología cualitativa, se recopilieron datos mediante entrevistas semiestructuradas, clases demostrativas y observación estructurada, involucrando a 12 estudiantes y 3 docentes. Durante las actividades prácticas, los participantes compartieron sus percepciones y experiencias. Los hallazgos destacan que el metaverso facilita la comprensión de conceptos complejos y fomenta la colaboración en entornos simulados, mientras que ChatGPT impulsa la autonomía y personalización del aprendizaje. Sin embargo, factores como conectividad limitada, equipos inadecuados y falta de experiencia previa dificultaron la implementación inicial. Se subraya la importancia de las guías pedagógicas para estructurar el uso de estas herramientas. La investigación concluye que la sinergia entre ChatGPT y el metaverso transforma la Educación Superior, requiriendo capacitaciones específicas y políticas inclusivas para garantizar equidad y efectividad en el acceso a estas tecnologías emergentes.

Palabras clave: Inteligencia Artificial Generativa, ChatGPT, Metaverso, Educación Superior, Estudio de caso.

1. Introduction

In a world transforming rapidly due to digital technologies, higher education institutions face the challenge of adapting their teaching methodologies to the demands of an interconnected and highly technological environment (Romero Carbonell et al., 2023). The implementation of cutting-edge technologies presents significant challenges, especially in Latin America, where factors such as infrastructure, educational investment, and government policies determine adoption capabilities. According to a UNESCO report (2023), 85% of universities globally report difficulties related to the lack of adequate infrastructure. In the Latin American context, these limitations can be even more pronounced due to economic inequalities, technological limitations, and traditional pedagogies (Observatory of the Monterrey Institute of Technology, 2024; Zapata, 2020). This situation calls for innovative approaches that guarantee equitable access to technology and inclusive pedagogical strategies aligned with the demands of the 21st century (Albuja Loachamín et al., 2023).

The digital divide, which is especially pronounced in rural areas, restricts access to technological tools that are essential for effective participation in today's knowledge-oriented society. This inequality affects both students and professors, who struggle due to heavy workloads, limited resources, and insufficient training in emerging technologies and modern pedagogical methodologies (Bonilla & Muñoz, 2022; Zapata, 2020). Thus, there is a need for educational policies that promote professional development of professors and equity in access to technologies.

In this context, immersive learning ecosystems emerge as a promising solution. This concept refers to educational environments that integrate advanced technologies such as virtual reality (VR), augmented reality (AR), and artificial intelligence (AI) to offer multisensory and adaptive experiences. These tools allow students to interact with simulated scenarios, promoting practical, collaborative, and personalized learning, which is particularly valuable in disciplines that require an applied understanding of complex concepts. These platforms encourage greater participation and the cultivation of practical and analytical skills (Fabris et al., 2019; UNESCO, 2023).

The combination of ChatGPT and the metaverse represents a transformative synergy in this landscape. ChatGPT, as an AI-based language model, facilitates personalized interactions in real time, while the metaverse creates immersive environments ideal for collaboration and experimentation (Barráez-Herrera, 2022). Wei et al. (2022) conducted a systematic review of virtual reality research and found that immersive environments improved the communication skills of participants. These technologies have the potential to overcome infrastructural and resource limitations in institutions with limited resources, as is the case with many universities in Ecuador (Castellá, 2023; Torres Vargas, 2023).

Recent literature has explored the potential of these tools from different perspectives. In the Ecuadorian context, theoretical and practical research offers a framework for addressing specific challenges related to infrastructural and educational equity. For example, ChatGPT could provide personalized tutoring in rural areas, while the metaverse could generate simulated spaces that overcome the physical and logistical limitations of many institutions. ChatGPT has high potential as a virtual tutor within the metaverse, allowing for personalized learning and improved interaction

between students and educational content. However, Galli and Kanobel (2023) emphasize the importance of teacher supervision to ensure the quality and accuracy of the responses generated, highlighting current technological limitations. On the other hand, González Alcaide (2024) points out that the combination of these technologies fosters collaborative and creative educational environments, although he warns of the ethical and privacy risks associated with their implementation.

From a teaching perspective, it is clear that adopting these tools requires significant changes in pedagogical practices, including continuing professor training and curriculum adaptation. Similarly, Jofre (2023) stresses the importance of ensuring equitable access to these technologies to prevent technological inequalities from perpetuating existing gaps in the education system. In turn, Mollick (2024) warns that excessive use of ChatGPT could turn it into a “crutch,” inhibiting the development of critical and analytical skills. Instead, he proposes strategic integration that promotes active learning and critical thinking.

In terms of innovation, the EdChat project combines ChatGPT with traditional chatbot frameworks to offer improved student support. This approach not only increases learning efficiency in virtual environments but also encourages closer interaction between students and educational resources (Wang et al., 2023). Complementarily, Malinka et al. (2023) highlight the impact of ChatGPT in technical areas such as programming, emphasizing the need to adjust assessment methodologies to ensure that these tools are used as support and not as a substitute for academic effort.

The cultural influence of these technologies has also been studied. López and Rahwan (2024) analyze how terms generated by language models such as ChatGPT are being adopted into everyday vocabulary, warning of possible implications for linguistic and cultural diversity, especially in academic contexts. They emphasize the importance of maintaining diversity in the development of these tools, arguing that the monopolization of language models could limit the pedagogical and cultural perspectives available.

Despite its potential benefits, the implementation of ChatGPT and the metaverse in Ecuadorian higher education faces significant barriers related to technological infrastructure, access equity, and professor training. Strategies such as investing in digital infrastructure, developing continuing training programs for professors in emerging technologies, and promoting inclusive public policies are essential to overcoming these limitations. These actions can facilitate a more inclusive and effective adoption of these tools in the national educational context. In addition, these limitations highlight the need for empirical studies that explore the applicability and adaptability of these technologies in local contexts, as well as investments in equipment acquisition and training that would enable professors and students to take full advantage of these tools (López-Belmonte et al., 2023).

This research aims to analyze the perceptions and experiences of professors and students regarding the synergy between ChatGPT and the metaverse in teaching-learning processes in a higher education institute of technology in Ecuador. A qualitative approach was chosen in order to identify the technological, pedagogical, and institutional challenges associated with the implementation of these tools, as well as to evaluate their impact on education dynamics. The following research questions

are posed: What are the perceptions and experiences of professors and students regarding the use of ChatGPT and the metaverse in higher education settings? How does the synergy between ChatGPT and the metaverse influence the dynamics of teaching-learning processes in higher education? What are the technological and pedagogical challenges for the use of ChatGPT and the metaverse in teaching-learning processes in higher education?

The objective of this study is to understand how ChatGPT and the metaverse interact together and how they affect teaching-learning processes. The relevance of this research lies in addressing an emerging and little-explored issue in Ecuador. Currently, the use of technologies such as ChatGPT and the metaverse has not been systematically evaluated, leaving a gap in our understanding of their impact on the personalization and effectiveness of learning. The findings of this study can contribute significantly to the development of guidelines that promote the effective and contextualized adoption of these tools. Likewise, this research can be used as a basis for inclusive educational policies that promote equity in access to immersive technologies and strengthen professor training, which are key factors for an educational system aligned with the demands of the 21st century.

2. Methodology

To address the study objectives, we used a qualitative approach that would allow us to explore and understand the experiences of students and professors in using ChatGPT and the metaverse in immersive learning environments. As qualitative methodology allows for an in-depth analysis of the perceptions and dynamics of interactions between actors, it is apt for this exploratory and descriptive research (Creswell & Poth, 2018).

2.1. Research design

The research design used was phenomenological, focusing on describing and analyzing the experiences and meanings attributed by participants to the use of ChatGPT and the metaverse in their teaching-learning processes. This design was particularly relevant for understanding the subjects' experiences in specific contexts, allowing for a detailed analysis of their perceptions and emotions in relation to educational technology (Van Manen, 2016).

2.2. Participants

The participants, comprising 3 professors and 12 students, were selected through purposive sampling from the administration program at the institution chosen for the case study. The inclusion criteria considered previous experience with ChatGPT and metaverse and the willingness to share perceptions in a detailed and reflective manner. In total, six students and three professors were interviewed, which ensured diversity and representativeness in the data obtained (Patton, 2015). This criterion allowed us to obtain meaningful perspectives from the direct users of these technologies, enriching the qualitative analysis (Merriam & Tisdell, 2015).

2.3. Data collection

Three main techniques were used for data collection: semi-structured interviews, demonstration classes, and structured observation.

- Semi-structured interviews: Interviews were conducted individually with a pre-designed script to explore specific topics related to the experience of use, benefits, and challenges in using ChatGPT and the metaverse. The questions addressed aspects such as the perception of personalization in learning, impact on motivation and engagement, and the technological and pedagogical challenges experienced. Each interview lasted approximately 45 minutes and was recorded and transcribed for later analysis (Kvale, 2008).
- Demonstration classes: Class activities were organized into two periods, marked by different objectives to be achieved and the use of specific technological tools. In the first period, independent work, information gathering, and critical thinking were planned. To this end, students used their mobile phones to access ChatGPT to obtain information related to the topic to be discussed in class (see Figure 1). In the second period, activities were carried out to apply the theory researched. The knowledge acquired was put into practice through the use of metaverse glasses¹, simulating work scenarios in academic contexts. These activities promoted the development of critical analysis, decision-making, and teamwork (see Figure 1). In both phases, support was provided by a professor and three students from the software program.

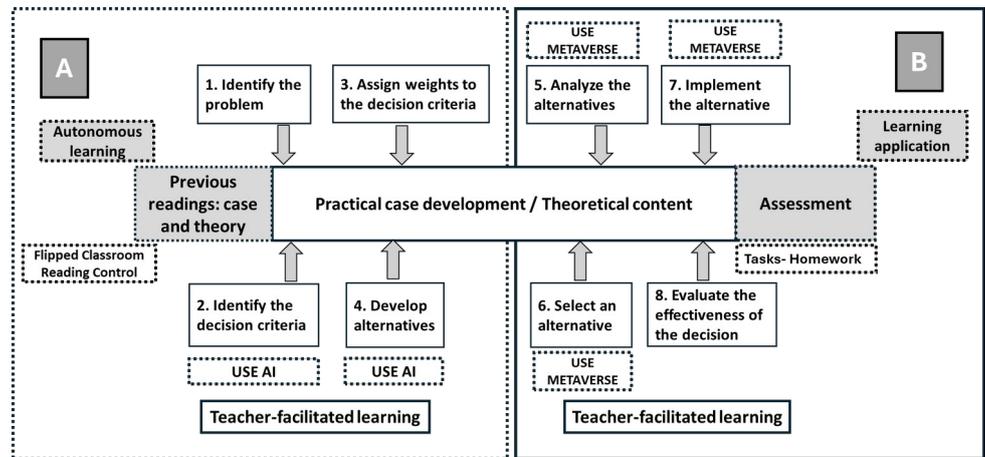


Figure 1. Class design.

- Structured observation: Each demonstration class was attended by an observer professor, who recorded specific behaviors such as frequency of participation, use of technologies, collaborative dynamics among students, and classroom management by the facilitating professor. This technique was complemented by field notes, which documented contextual and emotional aspects perceived in the participants. Structured observation provided a comprehensive view of the implementation of these technologies in the classroom and their impact on learning dynamics (Angrosino, 2012).

¹ Meta Quest 3 - Dual RGB camera with depth projector to combine physical and virtual spaces - 4K+ Infinite Display 2064x2208 pixels per eye with 90 Hz refresh rate (120 Hz in experimental mode) - Ring-Free Controllers, TruTouch Haptic Feedback.

2.4. Data analysis

The digital information collected in the interviews with students and professors was converted to text and processed using the Atlas.ti-24 software. Thematic and hermeneutic analysis was performed on the data, following the stages proposed by Braun and Clarke (2006): familiarization with the data, generation of initial codes, searching for themes, reviewing themes, and defining themes.

In the first stage, interview transcripts and observation notes were reviewed to identify relevant patterns and concepts. Subsequently, specific codes were developed that grouped the most significant ideas and experiences around the benefits, challenges, and perceptions of using ChatGPT and the metaverse. These codes were organized into themes and subthemes, which facilitated the interpretation of the results and the creation of solid analytical categories that reflected the participants' experience.

2.5. Case study

Instituto Superior Tecnológico "ISMAC" ("ISMAC" Higher Institute of Technology) was chosen as the site of case study due to its representativeness within the Ecuadorian higher education system, based on its number of students and the range of courses it offers.

This choice facilitated the analysis of teaching and learning processes. In addition, three of the authors of this study are employed at the institution in roles related to the research topic. It should be noted that ISMAC students belong to the low-income socioeconomic group and live in rural or suburban areas, where the digital divide is significant compared to most universities.

2.6. Ethical considerations

This study conforms to the fundamental ethical principles of research. Informed consent was obtained from each participant, with the guarantee of confidentiality and anonymity. Participants were informed about the study objective and their right to withdraw at any time without repercussions. Likewise, data privacy was ensured and participants were told that the results would be used exclusively for academic purposes (Flick, 2018).

2.7. Study limitations

While this study provides a detailed perspective on the impact of the synergy between ChatGPT and the metaverse on immersive education in Ecuador, the qualitative methodology and the small sample size limit the generalization of the results to other contexts or educational institutions. However, the findings provide a relevant basis for future research and the development of educational policies in this area.

3. Results

This case study revealed a significant range of experiences and perceptions regarding the use of immersive technologies and AI tools in the context of teaching and learning.

3.1. Perceptions and experiences of professors and students regarding the use of ChatGPT and the metaverse in higher education settings

An initial finding reflected perceptions about knowledge of these technological tools, with professors and students demonstrating a basic level of knowledge and use of ChatGPT. The level of knowledge of other technologies such as Gemini, Ideogram, and Copilot was even more limited. Likewise, a general lack of knowledge about the metaverse was observed among students and professors, especially in educational settings.

Students' experiences

The students were organized into groups and asked to solve a case or a math problem. An initial challenge arose during the search for information. The professors proposed a general initial prompt² as a basis for the search. The students took this input, but then began to perform other unscheduled searches, which forced them to redirect the search and come up with new prompts. One student commented:

«Initially, I got lost. I think I typed the directions wrong and the chat started showing me things I didn't understand» (Interview with student E2, August 7, 2024)

In addition, there were problems with the Internet signal, which was very slow and had several interruptions, forcing a change of network in order to continue with the class. It should also be noted that the students' cell phones varied greatly in terms of their technological characteristics, which led to disparities in the speed at which information could be obtained. Two students pointed this out:

"The Internet affected us. We had to keep entering information all the time, and it took a long time to respond" (Interview with student E1, August 7, 2024).

"My cell phone is old and sometimes causes me problems when I use it. We had to use a classmate's cell phone to quickly look up the information" (Interview with student E4, August 8, 2024).

As for the metaverse, the initial experiences were marked by unfamiliarity with the glasses and controllers. Consequently, the students required considerable time to get comfortable with the tool and use it without problems. During this phase, there were also interruptions due to issues such as not quickly locating the environment where they were supposed to work, selecting avatars, and the various resources they could use to interact with others in the virtual reality, such as whiteboards, annotations, or manipulating three-dimensional objects. One student pointed out:

² An AI prompt is an instruction or set of words provided to an AI system to perform a specific task, such as generating text, images, or code. The clarity and precision of the prompt determine the quality of the model's response - Hostinger. (2023, September 5).

"It was a little difficult at the beginning. I was lost, but slowly I realized how it worked and I calmed down" (Interview with student E3, August 7, 2024).

Professors' experiences

The professors developed and shared learning guidelines with students. Planning the guidelines led the professors to rethink the traditional approaches they had been using in their classes, which in turn led them to rethink activities for independent learning and for using technological tools. Before implementing the demonstration classes, participating professors received basic training in the use of metaverse equipment. Like the students, the professors faced problems while using the metaverse equipment as its use requires the development of digital skills. One professor pointed out:

"This is a new experience for me. I found these glasses interesting. It's a whole new world for me. You have to learn how to use them properly before you can teach others. (Interview with professor D3, July 24, 2024).

The lack of previous experience with immersive technologies was a considerable barrier for some students and professors, especially in the use of devices such as virtual reality glasses and in the formulation of effective questions for the AI tool (known as prompt engineering)³. This adaptation process was described as challenging by professors, who expressed the need for specialized training to optimize its integration in the classroom. One professor stated:

"I see that these tools are revolutionizing the way students can interact. They can review theory and interact in a practical way. This is good for their learning experience. But it is difficult for me to use these tools due to my lack of specialized training" (Interview with professor D1, July 24, 2024).

The teaching guidelines played a fundamental role in facilitating a comprehensive educational experience within the framework of the implementation of immersive technologies. This tool contributed significantly to meaningful learning and the development of social skills in students. One professor shared her experience, stating:

"The guidelines were very helpful. At the beginning I was hesitant, I was lost, but then with the guidelines, I was able to teach the class without any problems" (Interview with professor D2, July 24, 2024).

This testimony highlights the value of learning guidelines as a key resource in guiding and executing pedagogical activities.

Professors also highlighted the structure and clarity provided by the learning guidelines, elements that proved essential to the success of the teaching process. Under the activity instructions outlined in these guidelines, professors were able to better organize and deliver their classes, thereby promoting a more effective educational environment. In addition, it was emphasized that the guidelines fostered student autonomy by including specific indications that allowed them to make informed decisions, strengthening their capacity for independent and critical learning. One professor pointed out:

³ An AI prompt is an instruction or set of words provided to an AI system to perform a specific task, such as generating text, images, or code. The clarity and precision of the prompt determine the quality of the model's response - Hostinger. (2023, September 5)

"The guidelines were like a map. We all knew what needed to be done in class, and when questions arose, we referred back to the guidelines to continue and guide the students" (Interview with professor D1, July 24, 2024).

Another aspect highlighted by professors was the influence of the learning guidelines on the personalization and adaptation of the educational context. The guidelines allowed the content and teaching strategies to be adjusted to the specific needs of each group of students, taking into account their prior knowledge and contextual particularities. This flexibility helped improve the relevance and effectiveness of the educational processes, promoting a more equitable and meaningful experience for all participants.

The use of ChatGPT did not pose a major problem, as professors had previous experience with it. Considerable time was spent on the creation of prompts to be used by students. Several were proposed for each stage of the information search and then for decision-making. One professor stated:

"We had already been using ChatGPT before, even with the same students. I realize that the prompts need to be well crafted. That's key" (Interview with professor D3, July 24, 2024).

Classroom management presented some monitoring challenges for the professors due to their lack of experience in using the metaverse control tool from the laptop that was used as the monitoring center. For example, some voice commands issued from the professor's microphone were not clearly understood by the students. These technical audio issues delayed the progress of the class and created situations where students did not know how to act. Once the initial technological problems were overcome, the class proceeded normally as planned in the learning guidelines.

3.2. Influence of the synergy between ChatGPT and the metaverse on the dynamics of teaching-learning processes in higher education

The combination of immersive environments promoted dynamic, student-centered interactions, prioritizing personalized learning and the development of autonomous skills. We highlight some aspects of the noted influence.

Autonomy and personalization in learning

ChatGPT served as an academic assistant that enhanced students' skills in efficiently searching for and organizing information. Initially, students worked individually and then in groups, with little influence from professors, which allowed them to conduct personalized searches, collect data, and delve deeper into specific topics. This approach fostered autonomy in learning, improving the ability to make informed decisions and solve problems. One student pointed out:

"I was able to progress at my own pace. I researched some things that I didn't fully understand. I didn't need to ask the professor to explain things to me. It gave me the confidence to learn on my own" (Interview with student E6, August 8, 2024).

Subsequently, students applied the knowledge acquired with ChatGPT in the metaverse, interacting in three-dimensional scenarios that facilitated the

understanding of complex concepts. These practical experiences enriched their academic training and strengthened their analytical skills. One student described their experience as follows:

"It was like being in a real company. We were able to apply what we had researched beforehand in ChatGPT without the professor's assistance. The class was more dynamic and useful for my training" (Interview with student E5, August 8, 2024).

For professors, ChatGPT proved to be a key tool for designing personalized activities for student groups. It also allowed them to ask specific questions, access relevant information, and provide effective feedback on case studies. One professor stated:

"This tool allows you to ask specific questions and explore possible answers in a flexible way. It was very useful for my classes" (Interview with professor D1, July 24, 2024).

However, familiarity with these technologies varied among professors, emphasizing the need for continuing training to maximize the potential of AI in education.

Collaborative learning

The metaverse promoted collaborative learning, giving students the opportunity to interact in real time and work on group projects, which encouraged joint problem solving and the discussion of ideas in a simulated environment. This learning model promoted the co-creation of knowledge, strengthening key social skills such as cooperation, communication, and teamwork. One student highlighted the importance of this approach when describing their experience in the metaverse:

"I was able to work effectively as part of a team with my classmates. I think it was a good experience" (Interview with student E3, August 7, 2024).

Reconfiguration of professor and student roles

The synergy between ChatGPT and the metaverse changed the dynamics of interaction between students and professors. As students were able to obtain instant answers and constant self-feedback, their dependence on repeated professor consultation was reduced. This set the stage for true student-centered learning. One student commented:

"The good thing was that we practically taught ourselves. The professor did help, but we did most of it ourselves" (Interview with student E1, August 7, 2024).

In turn, professors focused on more complex tasks, such as creating interactive projects and qualitatively analyzing student performance in class. This change allowed professors to take on the role of learning facilitators, focusing on personalized support and supervising the progress of the working groups involved in the demonstration classes. One professor commented on this development:

"With AI I feel that I have been freed from routine tasks. It frees up more time for other activities that I have always wanted to do" (Interview with professor D3, July 24, 2024).

On the other hand, the use of the metaverse allowed professors to design learning environments tailored to the levels and needs of the working groups, increasing their motivation and commitment to the educational process. In addition, it offered the flexibility to make modifications in real time, adjusting learning experiences according to the students' responses, generating a flexible and adaptable educational proposal.

Development of technological and soft skills

Interaction with AI tools and immersive environments proved to be a transformative educational experience, especially in fostering specific skills in students. In the case of ChatGPT, the importance of prompt engineering was realized, as most students initially asked very general questions that limited the AI's potential to generate personalized and specific responses. This challenge was overcome through professor support, leading to an improvement in the quality of the questions, which helped obtain more accurate information to solve the case or math exercises. This process not only optimized learning but also developed key skills such as the ability to formulate clear and specific questions, critical thinking to evaluate answers, and adaptability to interact with the tool in an iterative and adaptive manner.

The metaverse facilitated practical learning by providing the possibility of simulating professional contexts. Students determined that the metaverse allowed them to acquire applied skills such as collaboration, problem solving, and effective communication. One student commented:

"Learning how to use these technologies allowed me to understand how they apply to my future work" (Interview with student E4, August 8, 2024).

These skills, aligned with the demands of today's job market, strengthened collaborative learning and responsible use of the metaverse.

Quality of the educational process

The personalization of learning through the synergy between ChatGPT and the metaverse improved educational quality by increasing student engagement and promoting independent and relevant learning. This adaptive model allowed students to progress at their own pace, receive instant feedback, and apply theoretical knowledge in simulated contexts. One student stated:

"The important benefit I notice in learning about the metaverse is to innovate and learn regardless of location" (Interview with student E2, August 7, 2024).

Access to personalized information encouraged skills such as critical thinking and effective questioning, while virtual scenarios fostered collaboration and real-time decision-making. These experiences also facilitated the understanding of complex concepts and promoted the development of technological and interpersonal skills. As one student pointed out:

"I learned to analyze AI responses, not just copy and paste, but to analyze the information" (Interview with student E5, August 8, 2024).

Professors and students agreed that the combination of these tools allowed for the design of dynamic and contextual educational experiences that enriched research, analysis, and classroom participation. Likewise, the ability to visualize and manipulate three-dimensional objects in real time promoted practical and meaningful learning, thus contributing to the overall improvement of the educational process.

3.3. Technological and pedagogical challenges for the implementation of ChatGPT and the metaverse in teaching-learning processes in Higher Education

Combining AI and immersive environments promoted more dynamic and student-centered interactions, fostering a pedagogical practice that prioritized the personalization of learning and the development of autonomous skills. However, implementing this form of AI-based digital learning in higher education institutions in Ecuador is challenging.

Technological challenges

The effort to combine ChatGPT and the metaverse in this case study revealed significant technological challenges that limited effective implementation. One of the main problems identified was insufficient technological infrastructure, especially in terms of Internet connectivity. Slow and unstable connectivity significantly affected the continuity of interactions in immersive environments, making it difficult to access and take full advantage of the technological tools available. Thus, a stable infrastructure is essential for the success of such innovations.

Students' and professors' lack of prior experience with immersive and AI tools represented a major obstacle. For example, interaction with ChatGPT required specific skills, such as prompt engineering, that were initially undeveloped. Similarly, using the metaverse demanded technical knowledge to handle devices such as virtual reality glasses. This highlighted the need to provide specialized training to both students and professors to ensure efficient and responsible use of these tools.

Overall, these findings emphasized that overcoming technological and training barriers is imperative to maximize the educational potential of the synergy between ChatGPT and the metaverse in Ecuadorian higher education.

Pedagogical challenges

Students and professors agreed on the importance of consolidating ChatGPT as a key academic assistant for searching, gathering and organizing information, fostering autonomy in learning, informed decision making, and problem solving. One student said:

"I hope to continue with all the activities we did in the demonstration class. It was a good experience. It helped us, especially ChatGPT" (Interview with student E6, August 8, 2024).

The need for a clear methodology for the combined use of ChatGPT and the metaverse was emphasized, along with practical guidelines that facilitate independent and group work. This includes guidelines on equipment management and the potential of each tool. One student pointed out:

"It would be good to develop more cases in the future where we can simulate the reality of a profession" (Interview with student E2, August 7, 2024).

In addition, the value of collaborative work was highlighted, where real-time interactions and group projects helped the development of social skills. One student stated:

"I liked working in groups because it was more effective. I learned a lot"
(Interview with student E3, 7 August 2024).

The use of ChatGPT to solve basic queries also reduced the teaching load, allowing professors to take on roles more oriented to facilitation. However, customizing educational environments according to the needs of each group and aligning them with innovative pedagogies was challenging. Professors as well as students stressed the importance of continuing training in immersive tools and AI, in addition to updating institutional technological infrastructures. In summary, the study reflects the benefits and challenges of integrating ChatGPT and the metaverse in higher education, highlighting the need for resources, training, and clear methodologies to maximize their impact on learning ecosystems.

4. Conclusion-Discussion

This research shows how ChatGPT and the metaverse could transform education in Ecuador's higher institutes of technology. These tools reconfigure teaching towards a personalized, collaborative and student-centered model.

By integrating AI and immersive environments, innovative pedagogical strategies are promoted to partially overcome the technological and pedagogical barriers in the educational system.

This study emphasizes the effectiveness of ChatGPT in personalizing learning, facilitating immediate responses that foster student autonomy. Its recurrent use improved students' confidence in formulating structured questions, leading to the development of critical and analytical skills. In addition, the metaverse stands out as a key tool for simulating professional scenarios by promoting collaboration and problem solving in three-dimensional environments, strengthening practical and experiential learning. Both technologies worked synergistically to enrich teaching-learning dynamics and student skills.

This study shows how ChatGPT and the metaverse impact the autonomy and personalization of learning and reconfigure educational roles. Students become active agents of learning, while professors take on roles as facilitators and designers of meaningful experiences. This role modification supports adaptation to the individual needs of students, promoting more inclusive and effective learning. Moreover, these technologies are especially beneficial in diverse and multicultural educational environments, consolidating their role in the modernization of education.

The use of ChatGPT reveals a significant learning curve for students and professors, especially in terms of formulating effective questions (prompts). This aspect, identified as an initial challenge, was overcome by the support of professors and the design of pedagogical guidelines for using the tool. The training sessions, integrated into the development of the project, were key to mitigate the initial resistance to technological change, encouraging greater acceptance and use of digital tools.

The immersive experiences in the metaverse, although challenging in terms of technical implementation, allowed students to develop technological and soft skills such as collaboration, conflict resolution, and effective communication. These results are consistent with studies such as Wei et al. (2022) validating the efficacy of immersive environments to reinforce practical and experiential learning.

Comparisons with previous studies reinforce the benefits of these technologies. Galli and Kanobel (2023) highlight that ChatGPT personalizes learning, while Mollick (2024) stresses the importance of strategies that foster critical thinking. In this study, ChatGPT proved to be essential for fostering student autonomy, and the metaverse served as a catalyst for collaborative learning. In addition, these tools proved to be highly adaptable to the specific needs of students, indicating their applicability in diverse educational contexts and consolidating their transformative potential in education.

From a theoretical perspective, these results reinforce the applicability of social constructivism in technologized educational environments. The interaction between students and technological tools, mediated by professors, validates the constructivist approach by allowing knowledge to be constructed in an active and contextual manner. In addition, the combination of ChatGPT and the metaverse broadens the scope of experiential learning, integrating emerging technologies that facilitate practical exploration of theoretical concepts.

The findings of this study highlight the importance of implementing educational policies that promote the continuing training of professors in the use of AI tools and immersive environments. These technologies require constant training, especially in the Ecuadorian context, where technological inequalities limit equitable access to pedagogical innovations. Ensuring an adequate and accessible technological infrastructure is crucial to maximize the impact of these tools in education and overcome existing barriers.

The study results highlight the need to design pedagogical interventions that consider both cultural diversity and the specific needs of students. ChatGPT and metaverse offer the possibility of personalizing learning experiences according to the socioeconomic and cultural context of students, making education more inclusive and effective. In this way, technological tools make it possible to close learning gaps, especially in communities where access to resources is limited.

However, in addition to the significant contributions, the study has limitations derived from its qualitative design. The sample of participants, although representative of the institutional context analyzed, does not allow generalizing the results to other educational institutions with different characteristics. Likewise, technological restrictions, such as limited connectivity and differences in access to technological devices, partially conditioned the implementation of the planned activities, affecting the full scope of the tools studied.

Future research could expand the sample size to analyze how these technologies impact different contexts, both in urban and rural universities. It would also be relevant to explore how tools such as ChatGPT and the metaverse can influence specific disciplines, such as technical sciences and humanities, in order to identify adaptive pedagogical approaches. Furthermore, it is essential to investigate how these

technologies can be used to close learning gaps for students with special educational needs, providing more inclusive and accessible solutions.

The results obtained corroborate that the integration of ChatGPT and the metaverse generates a favorable impact on teaching-learning processes. These technologies favor learning personalization, promote the development of technological skills, enhance collaboration, and expand pedagogical possibilities towards more inclusive and adaptive educational models. This approach not only responds to the current demands of the educational system, but also anticipates future transformations, consolidating a learning model that coordinates technology with human needs. The implementation of ChatGPT and the metaverse in the case study reconfigured traditional teaching methods, thus optimizing the students' learning experience.

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ARTICLE / ARTIGO

Race Against Diabetes: development and validation of a serious game prototype for school-based health education

Corrida contra o diabetes: construção e validação de protótipo de jogo sério para educação em saúde no ambiente escolar

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Abstract: The global rise in the incidence of diabetes mellitus, particularly among children and adolescents, highlights the need for innovative educational strategies in school settings. Serious games have proven promising for improving self-care and preventing complications by combining playfulness with evidence-based content. This methodological study was conducted in two phases: the development of the digital prototype Race Against Diabetes and its validation with experts (n = 6) and the target population (n = 20, aged 11–14). The content adhered to the ADCES7 guidelines and those of the Brazilian Diabetes Society and was assessed using the CVC, I-CVI, S-CVI/AVE, binomial test, and a Likert-based usability scale. The game is a 2D title developed in Unity/C++, featuring five levels focused on collecting healthy foods and learning about self-care. It achieved an S-CVI/AVE of 0.87, with some items showing a minimum I-CVI of 0.66 (p > 0.05). Usability was rated as satisfactory (mean score: 9.3 ± 2.65), with participants highlighting motivation, clarity, and learning. Race Against Diabetes shows strong potential as a pedagogical tool in health education, promoting knowledge and self-care skills through interactive gameplay. The pixel art design, chosen by students, further enhances engagement. Expansion to other platforms and long-term clinical impact studies are recommended.

Keywords: Diabetes Mellitus, Educational Games, Self-Management, Health Education, Adolescents.

Resumo: O aumento global da incidência de Diabetes Mellitus, especialmente entre crianças e adolescentes, destaca a necessidade de estratégias educativas inovadoras no ambiente escolar. Jogos sérios têm se mostrado promissores para aprimorar o autocuidado e prevenir complicações, ao combinar ludicidade e conteúdo científico direcionado. Realizou-se pesquisa metodológica em duas fases: desenvolvimento do protótipo digital «Corrida contra o diabetes» e validação com especialistas (n=6) e público-alvo (n=20, 11–14 anos). O conteúdo seguiu as diretrizes ADCES7 e da Sociedade Brasileira de Diabetes, e foi aferido por CVC, I-CVI e S-CVI/AVE, além de teste binomial e usabilidade baseada em escala Likert. O jogo é um título 2D em Unity/C++, com cinco fases de coleta de alimentos saudáveis e informações sobre autocuidado. Obteve S-CVI/AVE de 0.87 e I-CVI mínimos de 0,66 em alguns itens, todos com p>0.05. A usabilidade foi avaliada como satisfatória (média 9,3±2.65), destacando motivação, clareza e aprendizagem. «Corrida contra o diabetes» demonstra viabilidade como ferramenta pedagógica em saúde, promovendo conhecimentos e habilidades de autocuidado de forma interativa. O design pixel art, escolhido pelos alunos, potencializa o engajamento. Recomenda-se expansão para outras plataformas e estudos de impacto clínico a longo prazo.

Palavras-chave: Diabetes mellitus, Jogos educativos, Autogerenciamento, Educação em saúde, Adolescentes.

1. Introduction

The rising incidence and prevalence of diabetes mellitus (DM) have made it a global public health concern, with significant financial, health, and quality-of-life implications (International Diabetes Federation, 2022). In 2022 alone, approximately 201,000 new cases of type 1 diabetes mellitus (T1DM) were diagnosed in individuals under the age of 20, placing Brazil third worldwide in childhood and adolescent T1DM cases (International Diabetes Federation, 2022). In this context, schools—where children and adolescents spend much of their time and undergo cognitive, social, and cultural development—are considered key environments for health promotion, particularly for disease prevention and management. However, when aligned with the traditional biomedical model, schools have had limited success in fostering behavioral changes that support a healthier lifestyle (Mourão, 2023).

Therefore, the school setting should serve as a space for providing information, fostering learning, and supporting both children and adolescents—whether or not they have a diabetes diagnosis—in preventing disease and promoting health. It also plays a critical role in ensuring continuity of care and self-management practices, which can positively influence students' health outcomes and overall quality of life (Lee et al., 2020).

Against this backdrop, the use of educational technologies through collaborations between the education and health sectors, as well as multidisciplinary approaches to diabetes, has become a promising strategy to help children and adolescents learn about the condition. These tools can improve quality of life, reduce complication rates, and lower healthcare costs (Cobas et al., 2022). Serious games have increasingly been used in both education and healthcare as collaborative teaching strategies that promote students' skill development, autonomy, and competency building (Maskeliūnas et al., 2020). Clark C. Abt (1987) was the first to define serious games as those that go beyond entertainment, incorporating a clearly defined educational purpose. These games are designed with specific learning objectives and are used across various contexts, including schools, healthcare settings, professional training, and the simulation of real-life situations. While inherently playful, their core goal is to promote learning, enhance competencies, and foster critical thinking. As such, serious games function as tools for pedagogical and social interventions (Abt, 1987).

Serious games stand out as an educational technology in both school and healthcare settings, especially for children and adolescents. These games move beyond entertainment by delivering targeted, health-focused content and are used in teaching and learning processes to develop cognitive, psychomotor, and behavioral skills (Lima & Otero, 2024). The authors also emphasize that in pediatric contexts, serious games support treatment adherence for chronic conditions, reduce anxiety during medical interventions, and promote psychomotor development. In addition, Novák (2023) argues that involving children and adolescents in the development of a game about T1DM increases acceptance and engagement by making the content more accessible and better adapted to the specific needs of this population.

In health education, serious games have shown positive results, particularly when used in school-based educational campaigns, as they improve health literacy and

promote healthy behaviors among children and adolescents (Ancona et al., 2024). According to Liu et al. (2024), these games also encourage physical activity, especially when incorporated into ongoing interventions. Thus, serious games have proven to be valuable educational tools for addressing challenges in public health and education.

At both elementary and higher education levels, serious games have contributed to the development of cognitive, emotional, and social competencies. Studies indicate that when children and adolescents engage with well-structured serious games, they enhance critical thinking, creativity, and autonomy (Papanastasiou, Drigas & Skianis, 2022). In higher education, such games are used to foster meaningful learning on complex subjects (Celestini, 2020).

In health education, serious games are also used for professional training and patient care. Evidence shows that these tools increase students' confidence and health literacy, in contrast to traditional methods (Maheu-Cadotte et al., 2020). In pediatric contexts, they contribute to improved treatment acceptance, better mental health, and psychomotor development (Lima & Otero, 2024). As such, serious games are promising educational technologies that integrate health, education, and digital innovation.

Given this context, developing diabetes-focused games is expected to provide young people with knowledge about the disease, including its causes, symptoms, complications, treatment, and self-care practices. These tools can help promote health, prevent complications, encourage self-care, and improve quality of life. Reducing diabetes-related complications is particularly urgent, as they impose significant costs on Brazil's public health system. This study aimed to describe the development and validation of a serious game as an educational technology for diabetes education targeting children and adolescents.

2. Method

This was a methodological study conducted in two phases: (1) development of the digital game and (2) validation of the digital game with experts and the target population.

2.1. Development of the digital game

The game development process began with a needs assessment of the target audience, conducted through a field study at Municipal School Professora Maria Gondim dos Santos, located in Fortaleza (Ceará, Brazil).

A convenience sample of 20 students was selected, comprising five from each grade level (6th through 9th grades) of lower secondary school. As noted by Rehman et al. (2021), sample size may vary depending on the study objective. Small groups are effective in exploratory analyses, particularly when data are collected through observations and interviews. This sampling approach has also been applied in the validation of educational technologies to obtain direct feedback from the target audience (Mondellini et al., 2023). Initially, students were invited to participate and were provided with an Informed Consent Form (ICF) for children and adolescents, as well as an Assent Form for parents or legal guardians. A semi-structured questionnaire

was then administered, consisting of sociodemographic data and 12 questions related to diabetes.

The data collected were analyzed qualitatively and used in the actual game development phase. The participants' prior knowledge, perceived needs, and preferences regarding features considered appealing in a digital game served as the foundation for designing the serious game (Savi et al., 2010; Dabbs et al., 2009). The scientific content on diabetes was based on the seven self-care behaviors proposed by the American Association of Diabetes Educators (AADE) (Kolb, 2021) and the Guidelines of the Brazilian Diabetes Society (2022).

The game prototype was developed by a multidisciplinary team of professionals from the fields of health, education, information systems, and serious game development. The game was designed as computer-based software using simulations and iterative testing to improve functionality and ensure smooth gameplay. Development followed the four-phase process outlined by Chandler (2012): preproduction, production, testing, and post-production.

In the preproduction phase, the game concept, requirements, and planning were established. The production phase involved the development of programming, visual assets, audio components, and code, thereby building on the initial prototype. This stage also included the implementation of the preproduction report, which identified issues to be addressed (Chandler, 2012; Cruz-Cunha, 2013). Students participated in selecting the visual design elements, the game's title, and the main character's name. After this stage, the code was released for testing.

In the testing phase, the interface and programming were finalized, and alpha, beta, and gold versions were developed. In the alpha version, the development team tested functionality. The beta version addressed issues identified during alpha testing. The final gold version was submitted for expert validation in the field of diabetes (Chandler, 2012; Cruz-Cunha, 2013; Novak, 2012, 2024). Finally, during the post-production phase, a usability evaluation was conducted with the target audience.

2.2. Validation of the digital game by experts and the target audience

To assess content and face validity, eleven diabetes experts were invited to participate, of whom six completed the questionnaire. According to Pasquali (2013), six is an adequate number for this stage. Expert selection followed the criteria proposed by Jasper (1994). Searches on the Lattes Platform were conducted to confirm that the selection criteria had been met. Formal invitations were sent via email, and upon acceptance, participants were provided with the Informed Consent Form (ICF), an expert characterization form, screenshots of the game, and a link to the evaluation instrument via an online form.

The evaluation tool, adapted from Francisco (2019), included 14 questions distributed across three domains: content, language, and appearance. Each item had four response options on a Likert scale: (4) Strongly agree, (3) Agree, (2) Disagree, and (1) Strongly disagree. An open field was also provided for comments and suggestions aimed at improving the serious game. The original instrument consisted of 10 questions and had been developed to evaluate and validate a memory game on

leprosy. The adaptation consisted of replacing the term leprosy with diabetes and adding questions related to design, illustrations, and color choices in the game.

Data analysis was based on the Content Validity Coefficient (CVC), which measures the degree of agreement among experts. The CVC indicates the proportion of items rated as 3 or 4 by the panel of judges. Suggestions and proposed changes were reviewed and, when relevant, implemented (Polit & Beck, 2019).

For the analysis of the experts' responses, the Item-level Content Validity Index (I-CVI) and the Scale-level Content Validity Index using the Average Calculation Method (S-CVI/AVE) were calculated, with a minimum acceptable threshold of 0.78 (Polit & Beck, 2019). The exact binomial test was also performed, appropriate for small samples, considering a p-value greater than 0.05 and an agreement rate of 0.8 among the judges. Data were analyzed using Jamovi software (version 2.6). Usability was then assessed to evaluate the human-computer interaction, aiming to improve task performance, user comfort, and operability, thereby ensuring the quality of the interaction and software functionality (Castro et al., 2015). This phase was conducted at Professora Maria Gondim dos Santos School during science classes taught by the researcher, in Fortaleza, Ceará, Brazil, in November 2023.

The researcher's laptop was used to run the game. Initially, the opening screen was displayed, showing three command buttons: «Play» to start the first level of the game, «How to Play» to access the tutorial screen (game rules), and «Exit» to end the game. Next, participants were instructed to first access the tutorial and then start the game. After playing, each student completed the evaluation instrument. The game was tested by 20 children and adolescents aged 11 to 14, enrolled in lower secondary education and selected through convenience sampling. This moment proved highly enriching, as students showed strong engagement while playfully learning about health.

Usability was assessed individually using an evaluation instrument designed to determine whether the game fulfilled its intended goals of playability and learning construction. The instrument was based on the educational game evaluation model proposed by Savi et al. (2010) and contained nine questions. Scores ranged from 1 to 5 (unsatisfactory) and 6 to 10 (satisfactory). The criteria assessed included student motivation to use the educational game, the relationship between learning and fun, the quality of the game's illustrations, and the likelihood of students recommending it to peers. Suggestions provided during the usability evaluation may be incorporated into future versions of the educational technology, with support from an IT professional.

The Research Ethics Committee of the State University of Ceará (UECE) approved the study under number 6.272.309 and CAEE 68625323.7.0000.5534.

3. Results

3.1. Development of the digital game

During the needs assessment stage, it was found that most students defined diabetes as a disease that increases blood sugar levels and were unfamiliar with its symptoms,

causes, treatment, complications, and prevention. This information was used during the development phase to design an interactive, fun, and educational game set in everyday scenarios.

In the conceptual phase, the decision was made to create a digital serious game, designed to educate, train, and promote behavior change by presenting specific content in a playful and engaging way (Lima & Otero, 2024). The game design outlines all the components of the game, including gameplay, design, interface, characters, levels, and all features to be used throughout the experience. It provides a detailed description of the gameplay.

Following multidisciplinary team meetings and a literature review conducted during the planning stages, a storyline was developed based on environments from the daily lives of the target audience, to encourage positive decision-making to stay healthy and maintain blood glucose within target levels. *Racing Against Diabetes* (*Corrida contra o Diabetes*) is an original proposal, entirely conceptualized and developed by the authors based on educational objectives defined for the target audience. It is a standalone game created from scratch and categorized as a serious game for health education in the school setting. Its visual and functional elements were inspired by styles commonly found on open-source digital game platforms, which were consulted solely for exploratory analysis of aesthetics, design, and style in order to identify usability practices, accessible mechanics, and visual elements suitable for children and adolescents. However, it is important to emphasize that *Race Against Diabetes* features its own storyline, educational objectives, gameplay mechanics, and distinctive resources, and should not be regarded as an adaptation or modification of any pre-existing game.

The development of the Game Design Document was guided by the following components:

- **Mechanics:** This is a movement and item-collection game. The main character, named Dimi, moves through the environment to collect healthy foods while avoiding the villain (sugar). The gameplay includes a scoring system and interactive variables. The energy bar (representing blood glucose) must remain full by collecting healthy items. Collecting unhealthy items does not add points and also slows down Dimi's speed. If the energy bar becomes empty, the round ends. During each timed level, the player must achieve the required score and keep the energy bar above the minimum threshold before the countdown reaches zero. Contact with the villain temporarily reduces Dimi's speed. When pressing the «Z» key, informational speech bubbles appear, and the player interacts with characters who share information about diabetes and the seven self-care behaviors. An interactive soundtrack, along with reward and alert sounds, is triggered during collection, reinforcing desired behaviors. The game features five levels in which the main character (Dimi) runs through different environments. Movement is controlled using the «W» (up), «S» (down), «A» (left), and «D» (right) keys.
- **Narrative:** The game developed in this study is titled *Race Against Diabetes*, and the main character, Dimi, was named using the first syllables of diabetes mellitus. The target audience selected both the game's title and the main character's name during the first phase of the study. The game's narrative also includes seven friends who serve as supporting characters and one villain representing sugar

(hyperglycemia). Familiar everyday settings were chosen for the game scenes to resonate with the target audience. Dimi runs through various urban environments collecting healthy foods to refill his energy bar (glucose) while fleeing from the villain. Along the way, friends appear and interact with him, teaching him about the seven diabetes self-care behaviors. The goal is to foster learning around self-care, self-management, and diabetes control.

- Game strategy: The game was developed in 2D using the Unity game engine and programmed in C++, one of today's most widely used programming languages. Unity is a popular engine for developing 2D and 3D games, offering a robust and stable ecosystem that is highly compatible with various operating systems (Windows, macOS, Linux), thus ensuring broad accessibility for schools and end users. Its user-friendly interface also facilitates object, scene, and script management, which proved essential for rapid and iterative prototyping, particularly valuable in educational projects requiring ongoing testing with the target audience (Kohli et al., 2024). Unity is widely adopted by developers and features extensive repositories of assets and tools, providing continuous support and speeding up development. The use of C++ in combination with Unity's modular architecture enabled the creation of sophisticated game logic, allowing control of variables such as time, score, interactions, penalties, and individual player progress. It also made it easier to integrate pixel art graphics—an artistic style chosen for its strong visual appeal among children and adolescents (Aleksić & Simeunović, 2024). Lastly, Unity is recognized for performing well even on lower-end machines, ensuring the game can be played on school computers without requiring high processing capacity (Singh & Kaur, 2022; Gazis & Katsiri, 2023).
- Gameplay: The game consists of five levels in which points are awarded for each healthy food item collected. This point system acts as a reward and incentive to promote healthy habits and long-term behavior change. In the top corner of the screen, an energy bar (glucose) fills up as healthy items are collected and must be kept full to maintain controlled energy levels. Players advance to the next level upon reaching 200 points within the allotted time. Around ends in failure if the energy bar runs out or if the required 200 points are not reached before time expires. Additional information about the seven self-care behaviors in diabetes is presented through the interaction button to promote meaningful learning.
- Design: A 2D pixel art style was chosen for its emotional appeal, creating a sense of empathy through characters and visual elements that resonate with players. This feature supports meaningful learning (Bao, 2022; Aleksić & Simeunović, 2024). The graphic elements, created by a professional designer, were presented to researchers and participants, who provided feedback and suggestions. The soundtrack was selected to enhance the game's dynamics and align with the expectations and interests of the target audience. Race Against Diabetes stands out from other diabetes-related games due to its genre, design, presentation approach, and the way it delivers content. The game fosters agility and motor coordination as players collect food and reinforces the idea that only healthy foods earn points, which is crucial for glucose control. The 2D pixel model was chosen to build this serious game, featuring simple and engaging illustrations commonly used in games enjoyed by the target audience (Aleksić & Simeunović, 2024). The visuals are playful and appealing, reflecting everyday life for children and adolescents. Game scenes were based on daily settings relevant to the target audience. Some of these

represent self-care behaviors and feature a vibrant, colorful, and playful palette. In terms of text, distinct colors were used for the main character and villain, differing from those assigned to the supporting characters. The start screen of Race Against Diabetes displays one of the game environments and includes three command buttons: «Play» to start the first level, «How to Play» for the game instructions, and «Exit» to stop playing.



Figure 1. Start menu «Race Against Diabetes».

3.2. Validation of the digital game with experts and the target audience

During the validation phase, six experts—all women and nurses—participated, with a mean age of 43.5 ± 9.3 years and an average of 21.1 ± 9.2 years since graduation. All reported holding both a graduate certificate and a master's degree; half (3) had completed a PhD, and one was currently pursuing doctoral studies. They had professional experience in clinical care, teaching, and diabetes research, with an average of 17.8 ± 6.9 years in the field.

The serious game Race Against Diabetes achieved a satisfactory overall content validity index ($S-CVI/AVE = 0.87$), with the highest scores in the content domain, followed by language and appearance. The items «the illustrations stimulate students' interest» and «the text colors are appropriate and facilitate reading» received the lowest individual ratings ($I-CVI = 0.66$), possibly due to the experts' limited familiarity with the pixel art style. All items had p -values > 0.05 .

The suggestions made by the experts were incorporated to enhance the game's clarity and functionality for teaching and learning, including sentence restructuring for better comprehension, standardizing the word «diabetes» in the masculine form, using the abbreviations DM1 and DM2, adding periods to all sentences, and replacing «YOU LOST» with «Not this time» when the game objectives are not achieved.

Table 1. Validation of the digital game Race Against Diabetes. Fortaleza, CE, Brazil, 2023.

Validation of the digital game	CVI	p-value*
Content	0.97	
The game's content is appropriate for the target audience.	0.83	0.738
The content presents the topic of diabetes in a clear and straightforward manner.	1	1.000
The content is suitable for children and adolescents.	1	1.000
It helps answer questions about the topic.	1	1.000
It enhances knowledge in this field.	1	1.000
It encourages reflection on the topic.	1	1.000
Language	0.87	
The language used is easy for children and adolescents to understand.	1	1.000
The illustrations stimulate students' interest.	0.66	0.345
The language supports student learning.	1	1.000
The game rules are clear and easy to understand.	0.83	0.738
Aparência	0.83	
The text colors are appropriate and make reading easier.	0.66	0.345
The visual design is suitable and engaging for children and adolescents.	1	1.000
The shapes and colors of the illustrations are well-suited to this type of material.	0.83	0.738
The illustrations are appropriate for the type of material and the target audience.	0.83	0.738
Overall CVI	0.87	

p-value* binomial test

Following expert evaluation, the target audience assessed the game in a usability test and rated it as satisfactory (mean score = 9.3 ± 2.65). The domains of motivation, clarity, satisfaction, and learning all received excellent scores, ranging from 9.1 to 9.6. Based on the positive feedback from the target audience and the widespread appeal of the pixel art style among children and adolescents, the team decided to maintain the colorful and visually engaging design.

4. Discussion

Race Against Diabetes is a fun and engaging game designed to educate players about diabetes. This serious game, developed for diabetes education, was conceived as a pedagogical strategy to enhance attention span, foster problem-solving skills, creativity, and motivation, and encourage social interaction among students (Maskeliūnas et al., 2020). Video games promote learning playfully, increasing children's and adolescents' interest in and motivation for learning.

The seven self-care behaviors in diabetes comprise a robust framework for diabetes education and self-management support aimed at behavior change and improved clinical outcomes. Proposed by the Association of Diabetes Care and Education Specialists (ADCES7) (Kolb, 2021), these behaviors—healthy coping, healthy eating, being active, taking medication, monitoring, reducing risks, and problem-solving—demonstrate that improvements in learning, behavior, clinical outcomes, and

the effective use of technology can enhance both health outcomes and quality of life for people with diabetes. For this reason, the framework was used as a foundation in the game's development.

According to Makhlysheva (2013), the goals of serious games for diabetes are based on three pillars: nutrition, self-management, and physical activity. The game developed in this study, *Race Against Diabetes*, primarily focused on nutrition and information-sharing about diabetes. This focus was selected because students in school settings tend to choose unbalanced, ultra-processed foods and fast food. These eating habits often contribute to poorer outcomes in type 1 diabetes and increase the risk of obesity and type 2 diabetes in children and adolescents.

Race Against Diabetes is innovative in its format as a digital game, adopting a pixel art design similar to games created solely for entertainment, such as *Minecraft*, *Stardew Valley*, *Terraria*, and *Dave the Diver*, among others, commonly played by children and adolescents. This visual style evokes emotional responses in players, fostering greater engagement, interaction, concentration, and attraction to the game (Aleksić & Simeunović, 2024; Bao, 2022). This characteristic supports the meaningful learning proposed by the game, which features engaging and playful illustrations commonly used in entertainment games and closely tied to the everyday lives of children and adolescents.

The pixel art design style, although classic, remains widely used by digital game developers due to its practicality and aesthetic appeal. Pixels are points of light that form the visual structure of characters and scenarios in games (Silber, 2016).

Developing an educational game requires detailed planning, including script definition, gameplay elements, game phases, and graphic design, to ensure functionality (Machado et al., 2009). Therefore, the involvement of experts in health, education, and information technology, as well as the participation of the target audience, was essential. This collaboration has enabled the creation of a technology that is aligned with the target audience's real-life context, demonstrating strong usability and acceptability.

Behavioral changes among people with diabetes that result from the use of serious games stem from progressive learning and improved health literacy, as individuals gain knowledge about the disease and incorporate self-care and self-management practices (Oliveira, 2021). Thus, the game is expected to support the development of new skills and competencies in people with diabetes, contributing to better health outcomes and quality of life.

5. Conclusion

This study had some limitations, including the small number of experts who returned the evaluation instrument, the inability to provide them with access to the serious game for gameplay testing, and the restricted availability of the game on other platforms, limiting access for a broader audience of children and adolescents.

The educational serious game *Race Against Diabetes* offers an innovative approach to health learning. As an interactive and motivating tool, it elicits an

emotional response in players and aims to promote behavior change toward healthier living.

This research describes the development of the serious game Race Against Diabetes, which followed a rigorous methodological process and demonstrated satisfactory evidence of content and face validity, as well as positive usability ratings from the target audience. The game shows strong potential to support meaningful learning about diabetes mellitus by promoting the dissemination of information and encouraging the acquisition of knowledge, attitudes, and practices playfully related to health.

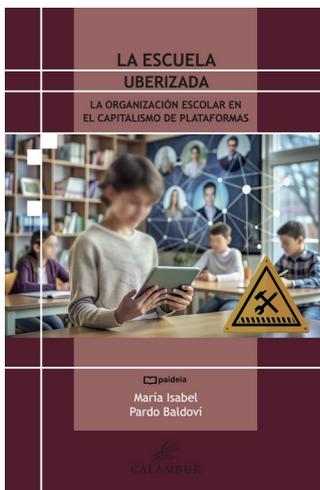
The game can be used both in and outside of the school setting, in public or private education systems. Furthermore, this study underscores the need for increased investment and collaboration between the health and education sectors, along with follow-up studies to assess outcomes such as knowledge, self-care behaviors, and clinical outcomes.

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REVIEW / RESEÑA / RESENHA

Pardo Baldoví, M. I (2024). *La escuela uberizada. La organización escolar en el capitalismo de plataformas*. Calambur

Elia Fernández-Díaz *

This book constitutes a thought-provoking contribution to the field of educational technology and school organization, offering essential insights for understanding the profound transformations driven by digital technologies in education. It invites readers to rethink the tensions between mechanisms of reproduction and transformation that characterize school functioning under the current platform capitalism. The book's core purpose is to analyze the metamorphosis of the organizational logic of an already «uberized» school—that is, a technologically and ideologically modified and abducted institution that legitimizes the knowledge, values, and principles of the prevailing model of social uberization, a model against which it must react and re-exist.

The publication stems from the doctoral thesis «The Impact of Digital Platforms on Early Childhood and Primary Education Teachers: The Precarization of Teaching Work» and forms part of the Paideia Collection published by Editorial Calambur, directed by Ángel San Martín Alonso and José Eliseo Valle Aparicio.

The book is structured in four distinct parts. Using the cybernetic metaphor of (logging > loading > updating > turning off), which shapes our daily digital routines, the author gradually and subtly draws the reader in. This metaphor is used to present the uberization scenario that pervades the school reality, delve into the features that define school organization in the current platform capitalism, and conclude with a manifesto that positions itself critically against the dominant uber ethos, envisioning an alternative school landscape.

After an initial log-in that introduces the phenomenon of uberization, the normalization of digital platforms in everyday life, and the newly imposed organizational logic, the second part of the book, titled «Loading», presents the conceptual foundations necessary to understand the notion of the «uberized school» across three chapters. The first chapter outlines the current school landscape, offering an extensive taxonomy of digital platforms that seduce and permeate the educational experience. The second chapter explores the ongoing transformation from a «school of technologies» to a «school of platforms»—a process driven by interests external to the education system that places platforms at the core of school functioning. Here, the author conducts a critical analysis of the key factors that have contributed to the technologization and legitimation of this new organizational logic, both at the discursive level and in practice, through supranationally orchestrated policies on resource allocation and teacher training. She also warns how the entrenched uberization ends up regulating the teacher's role, shaping practice through a competency-based model underpinned by the individualistic approach of cognitive capitalism and subordinating education's transformative potential to the technological values of the dominant social model.

Finally, the third chapter presents the foundations of the new paradigm of school organization. Far from reducing technologization to the mere implementation of digital platforms in educational tasks, it calls for reflection on the increasing sophistication and privatization of the school sphere, a colonizing process significantly accelerated by the COVID-19 pandemic. The author insightfully clarifies how the school, as a socializing agent, becomes an «invisible uberizing» force that facilitates and legitimizes the advance of the techno-economic revolution inherent to platform capitalism.

The third part of the book, «Updates are turning off. Do not shut down or unplug your device», comprises the following three chapters, which explore the consequences of

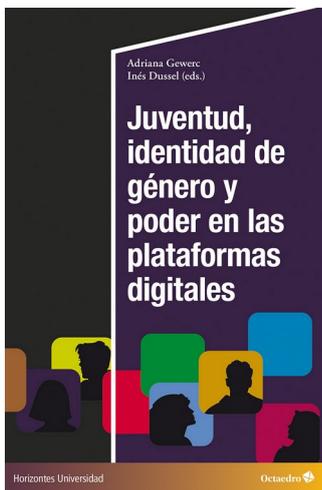
uberization in the transformation of school organization, the emergence of new forms of misgovernance, and the erosion of professional identity in teaching practice. The fourth chapter analyzes how school structures and cultures begin to embody the values of platforms: atomization, deregulation, control, and specialization become the hallmark of a complex structural web involving multiple actors who intervene in and disrupt organizational culture. This occurs within a holistic process of techno-culturalization that mediates representations, practices, and values, precarizing and technologizing the work of those in management roles.

Chapter five addresses the exercise of governance in this new «uberized school» scenario, focusing on how control networks in educational institutions become blurred, giving way to governance crafted under the aegis of neoliberalism. Beneath the illusion of autonomy, the author reveals a mechanism of deregulated re-centralization driven by an entire ecosystem of ubiquitous technologies, strategic alliances, and supranational policies. In this sense, the platforms not only prescribe and standardize work in schools but also perniciously reinforce and legitimize the system. This results in a form of corrupted post-bureaucracy, in which platforms channel accountability, quality standards, and teacher performance control, thereby extending the scope of uberized governance.

Chapter six delves into this process of ubiquitous disciplinary shaping of teacher subjectivities, examining how platforms act as a form of mass seduction, operating both symbolically and materially, by fostering dependence among teaching staff.

In the final part of the book, «Shut Down and Disconnect», the author concludes with a powerful manifesto-epilogue that urges critical reflection on the need to awaken and resist this silently enacted revolution that turns schools into a kind of app store—ever more invisible and anonymized within the proliferation of artificial intelligence. The manifesto advocates for reclaiming the school environment as a space for reflection, critical thinking, and human connection.

In short, this is a well-grounded, compelling, and highly relevant work—an essential reading that not only contributes significantly to understanding the uberization of education, but also invites us to rethink our own roles and responsibilities in teacher education. It calls for the reinvention of our university praxis «for and with» a school conceived as a space for freedom, urging us to step out of comfort zones, reawaken collective consciousness, and engage in the co-construction of pathways toward social transformation.



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RESEÑA / RESENHA / REVIEW

Gewerc, A., y Dussel, I. (Eds.). (2024). *Juventud, identidad de género y poder en las plataformas digitales*. Octaedro

Nicolás Cendrero Ramos*

This book is the result of a project coordinated by Adriana Gewerc, Professor of Educational Technology in the Department of Didactics and School Organization at the University of Santiago de Compostela, and Inés Dussel, Research Professor in the Department of Educational Research at Cinvestav-IPN in Mexico. The research has been funded by the Spanish Ministry of Science and Innovation (PID2019-108221RB-I00).

The book explores how adolescents in Ibero-America construct their gender identities through digital platforms such as Instagram, focusing on the contexts of Spain, Mexico, and Uruguay. It analyzes the influence of social media on the construction of gender subjectivity during adolescence, and seeks to reinterpret the sociocultural patterns specific to Ibero-American contexts. The findings reveal that, although there is a widespread pressure to be visible and socially acceptable on social media, adolescents' explanations vary according to their cultural and social contexts. The characteristics of digital platforms play a key role, generating discourses on gender identity that can be both normative and subversive.

The book emphasizes the importance of sociocultural contexts and platform economies in shaping identity and gender experiences, identifying a tension between the desire for visibility and the need for privacy, which results in complex forms of self-representation. Social networks shape people's lives by establishing synergies between personal experience and the logics of social or informational capitalism.

The book is structured around an introduction divided into three sections, which present the research context and objectives, as well as the importance of studying the construction of gendered subjectivities in digital environments. This introductory section is followed by seven chapters that address topics such as the study's methodology, the digital practices of Galician adolescents, the dynamics observed in Mexico, and the way gender affects self-perception. Each chapter concludes with a references section documenting the sources used. This structure allows for a comprehensive examination of the relationship between digital platforms and the construction of gender identities during adolescence, taking into account various sociocultural contexts across Ibero-America. Additionally, the book analyzes the production of gendered subjectivities among adolescents from different regions who share similar dynamics on social media.

The introduction, structured into three sections, organizes and frames the content of the book from a theoretical perspective to methodological development. The first section analyzes digital platforms as devices of subjectivation. In this context, algorithms collect data focused on user content and experience in order to guide behavior through continuous interaction with digital devices. As people publish and interact on social media, algorithms become increasingly specialized in learning from each user and presenting content aligned with their preferences, thereby generating experiences that progressively reflect their behavior. The purpose of this data collection is to utilize the information for commercial, political, or social purposes. The second section addresses the issue of gender in digital environments. Gender is defined as a set of effects produced on bodies, behaviors, and social relationships through a complex political technology. It is an inseparable element of the process by which individuals conceive of themselves and establish identity relationships with themselves and others. Gender construction begins with the assignment at birth and evolves throughout life, shaped by family, social institutions, and, increasingly, by social media. The third section outlines the structure of the book.

The research combines qualitative and quantitative data through a case study that includes ethnographic observation centered on the social media platform Instagram. The researchers analyzed posts made by adolescents in Spain and Mexico. This

platform is characterized by its audiovisual nature—primarily images and videos—which fosters an aesthetic influenced by influencer culture, adopted by adolescents as both an aesthetic and moral model. Finally, the last chapters of the book focus on the use of multiple accounts and the management of privacy in each one, as well as on the content adolescents choose to share based on the number of followers associated with each profile.

Chapter one outlines the methodological design of the research, which combines both quantitative and qualitative approaches. The EDIGA project emerged with the aim of analyzing and understanding the role that digital environments play in the process of constructing gender identities during adolescence. This analysis is carried out across various sociocultural contexts from a gender perspective. To study adolescents' practices on the social media platform Instagram, the researchers created a "friend account" that allowed them to follow participants and observe their profiles, as well as the content they posted during the analysis period. The observation focused on the content generated and shared, and on the role that the body plays in these posts, including the figure of influencers. The adolescents studied came from diverse backgrounds, defined not only by their country of origin but also by their socioeconomic status, gender, and the influence of their family environments.

This chapter focuses on Galicia, a region where rural and urban areas coexist, along with both inland and coastal zones, which makes it possible to observe significant socioeconomic differences. High levels of academic achievement and educational equity in the Galician school system stand out in comparison to other regions of Spain. The adolescents analyzed represent a generational shift, as they surpass the educational attainment of their parents. This chapter examines digital practices on Instagram among Galician adolescents, who use this social network to connect and share aspects of their daily lives. The study also seeks to dismantle the stereotype of Galician conservatism and to demystify the notion of a traditional matriarchy. The latter, associated with the role of the youngest daughter as a caregiver within the family, is viewed as a burden that may limit her future choices. Interviews were conducted with adolescents of different sexes to explore how they identify in terms of gender, sex, and sexuality.

The results indicate that favorable attitudes toward the LGTBQ+ community are not necessarily linked to age or environment, but rather to family values and the gender of the participants. The use of social media typically begins around the age of 12, which is below the minimum age recommended by the platforms themselves. Moreover, adolescents often use multiple accounts: a main account for interacting with general acquaintances and a secondary account reserved for close friends. Female adolescents express greater concern about meeting certain quality standards in their posts, in contrast to male adolescents, who tend to take and upload fewer photos, displaying a more relaxed attitude toward posting.

Chapter three examines the influence of role models on social media, framed within the context of Mexican society. It is structured into four sections that address the sociopolitical context, educational dynamics, general findings from surveys, and the role of the family. Despite significant socioeconomic inequalities, Mexico is one of the countries with the highest wealth generation in the region. However, many areas are controlled by criminal gangs, which creates ongoing concern about digital security. This concern is reflected in the widespread use of private social media profiles as a means of protecting against account theft and other cybercrimes. In terms of social media usage, Mexico has a high number of users. Facebook is used more frequently than Instagram, and the average time spent on social networks surpasses that recorded in Spain. Adolescents acknowledge the authority exercised by families and teachers, and gender emerges as a factor that exacerbates the violence they experience, often originating within the family environment.

Digital affiliations function as forms of social capital. In the Mexican context, adolescence tends to be rendered invisible, lacking clear age boundaries and often associated with passivity. The educational level of the study sample falls below the national average, and many families have low levels of higher education. New lines of research are identified, focusing on the role of families and representations of romantic love. The interviewed adolescent girls perceive both society and their own families as patriarchal. Male adolescents, for their part, reproduce traditional gender roles: they associate women with caregiving responsibilities while positioning

themselves as leaders or protectors within the family structure, reinforcing their place at the top of the patriarchal hierarchy. In addition, the symbolic importance of appearing in a relationship on social media is observed, reconfiguring affective relationships according to logics of consumption and digital mediation. Finally, the chapter documents a negative attitude toward individuals who are not originally from the community, reinforcing a more closed and exclusionary local identity.

The following chapter focuses on how adolescents interact with influencers and the feedback they receive. It presents four case studies of adolescents from Mexico and Spain, with the aim of analyzing the influence of Instagram's architecture on their digital visual practices. In Spain, digital migration has followed a progression from Tuenti to Facebook, and from Facebook to Instagram; currently, this migration is shifting toward TikTok. In contrast, in Mexico, there is greater female participation in social media use, with Facebook being the most widely used platform. Families play a key role in shaping parental mediation regarding adolescents' use of these platforms. Moreover, algorithms—designed in predominantly male-dominated environments—introduce biases in user interactions and content production. Instagram is a clear example, as it promotes the pursuit of aesthetic forms through filters that enhance images, primarily to attract likes.

This chapter also explores the influences that adolescents receive and the differences between the Spanish and Mexican contexts. The dominant social media platforms differ, as do the levels of privacy and security configured in their profiles. Additionally, the chapter analyzes the aesthetic organization of adolescents' posts and accounts, as well as the influence exerted by their digital role models in shaping these aspects. Instagram fosters user dependency through mechanisms that encourage continuous presence and engagement on the platform. Four main areas of action are highlighted: the homogenization of youth expression; the promotion of constant activity on the platform; the aesthetic design of profiles; and the use of hashtags and music as tools to increase visibility.

Chapter five presents the culture of influencers and everything it entails, grounded in the notion of celebrity capital. This emerging industry has multiple economic and social effects, and its growth is driven by image-centered digital platforms. For adolescents, influencers represent both a professional and personal ideal, associated with the potential to achieve fame and financial gain independently. The culture of celebrities has extended to a micro level, becoming a reference point for individual behaviors that imitate the aesthetics and gestures of these figures. In the case of Mexico, adolescents identify singers, musicians, friends, and family members as role models, who are increasingly gaining relevance as new influencers on platforms such as Instagram, TikTok, or YouTube. With regard to gender, there is a growing trend toward following male figures. These include both international and national personalities from sports and music, as well as influencers who are dedicated exclusively to content creation on social media. Notable differences exist between countries in terms of the figures adolescents follow and the gender identities those figures embody.

Through content creation, users receive feedback from their followers, which highlights the tyranny of the like among Generation Z. Adolescents incorporate their role models into their modes of expression and their posts, as well as into the construction of the identity they wish to project to their audience. In Mexico, adolescents tend to follow athletes or musicians who have overcome significant barriers, allowing them to imagine personal success stories—such as "rising from nothing" to achieve prominence. Compared to Spain, there is a greater preference in Mexico for morally acceptable role models, albeit within certain critical limits. This tendency reflects a search for psychological and emotional well-being. A social hegemony of patriarchy is also evident, reproduced through social media. Additionally, a difference is observed between the two countries: in Spain, there is a higher level of content production and engagement on social media, while in Mexico, a more reflective stance prevails regarding the role these platforms play in the construction of youth identity.

Chapter six presents the personal profile as a practice of self-representation, in which the individual's image and personal information become a showcase for the commodification of subjectivity. In this context, the user becomes an entrepreneur of the self, making visible the practices developed by adolescents on Instagram, with

particular attention to how they manage privacy across their profiles and personal spaces. Updates that allow the use of multiple accounts (multi-accounting) provide an opportunity to experiment with different forms of self-representation. The use of several accounts enables the construction of simultaneous representations of the same person, each with differently configured levels of privacy.

The main account is typically dedicated to an idealized self-representation, driven by popularity and virality. In this space, aesthetic pressure leads to a stylized and conservative version of the self. In contrast, the secondary account reflects a more relaxed attitude, where adolescents step away from the persona created on their main profile. This secondary account is more personal, generally limited to close friends, unlike the main account, which is open to a broader audience. The main account is characterized by more polished, detailed, and carefully curated content compared to the secondary one. In relation to these practices, the chapter introduces the concept of *instagramismo*, understood as a set of aesthetic codes that both propose and encourage the display of the best version of the self, of one's experiences, and of daily life. In this context, privacy becomes a form of currency to gain visibility, accumulating social capital through controlled exposure. Adolescents engage in a constant negotiation between what is public and what is private, establishing the boundaries of what can be shown to a wide audience. This process influences not only the expression of emotions but also the representation—and, in some cases, the sexualization—of their own bodies.

The final chapter analyzes visual practices and the construction of gender identities on the platform. Emphasis is placed on the poses adolescents adopt in their images, where a dynamic interplay emerges between intimacy, self-awareness, and bodily appropriation. The illusion of ephemerality is especially evident through the use of stories. Adolescents tend to repeat styles and behaviors considered "trendy," aiming to project a positive image based on attributes linked to aesthetic and physical beauty. They follow famous individuals as a symbolic way of connecting with their popularity. The findings suggest that adolescents seek to express their identity and gain social recognition.

Their posts often reflect meticulous preparation, particularly in solo photographs. Within the patriarchal imaginary, women are associated with sexualized physical attributes, while men are linked to a form of masculinity grounded in traits such as aggression or rebellion, reinforcing the role of the man as a protective and territorial figure. In the case of non-binary individuals, the use of filters and camera angles stands out as a strategy to avoid certain poses or direct exposure of the body, driven by feelings of discomfort or insecurity. The various forms of representation adolescents adopt in front of the camera can be understood as multiple agencies that intersect and shift through contemporary aesthetics and fashion. To conclude, the chapter poses open-ended questions that invite future research on the gender dispositif and how platforms shape identities in ways that serve their economic interests.

This book addresses topics such as identity construction during adolescence through the use of the social media platform Instagram as a space for gender expression, highlighting notable differences among various gender identities. It analyzes how adolescents use this platform to express themselves, emphasizing the influence of images and performance in the construction of femininity, as well as the tensions between authenticity and conformity in their identity expressions. The book examines the distinction between public and private spaces on the platform, as well as between permanent content posted on feeds—which is generally more curated—and the ephemeral content shared via stories, where a more casual and authentic expression tends to prevail. The impact of aesthetic culture, combined with the influence of influencers, drives adolescents to conform to visual standards imposed by trends in order to gain likes, even when these representations do not faithfully reflect their reality. Such practices may reinforce gender stereotypes and social expectations that restrict authentic self-expression.

The analysis reveals that digital platforms like Instagram function as complex spaces in which adolescents negotiate their identities within a context of social surveillance and aesthetic pressure. Posting practices not only reflect personal experiences but are also shaped by cultural norms and gender expectations. This study provides a solid foundation for future research on the intersection of gender, youth, and digital media.

Furthermore, it underscores the need for a critical approach in educational processes related to the use of social networks and highlights the urgency of further investigations into the construction of gender identity and subjectivity in today's digital context.



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RESEÑA / RESENHA / REVIEW

Pardo Baldoví, M. I. (2025). *Plataformas, Influencers Educativos y Otras Especies del Bestiario de la Escuela Digital*. Edit.um

Fernando Fraga-Varela*

The book «Plataformas, Influencers Educativos y otras especies del Bestiario de la Escuela Digital» is authored by Professor María Isabel Pardo Baldoví, from the Department of Didactics and School Organization at the University of Valencia. It is a timely and necessary contribution situated firmly within the field of Educational Technology. The work is grounded in the author's doctoral thesis and her involvement in various research projects.

This book invites the reader to reconsider the metaphors that have shaped the collective imaginary of schools and teachers, pointing out the inadequacy of those used thus far. It challenges us to reflect on the current condition of the teaching profession through lenses that have often been absent in previous approaches—particularly in light of the growing influence of digital technologies. One key area examined is teacher education and the different forms of rationality—technical, practical, or critical—drawing on Frankfurt School perspectives on education. The book argues that we must reconnect with reality by constructing new fictions that enable us to engage with today's educational landscape. It is a journey in which readers may see themselves reflected, prompting them to reconsider their own roles as educators—including those in higher education.

The author guides us through four chapters, exploring the new ecosystems of teaching and learning, the evolving characteristics of the teaching profession in today's educational environment, and how teacher subjectivities are being shaped in this new context. This exploration culminates in an extensive typology that helps readers understand the different ways teachers adapt to survive professionally.

What is particularly compelling is that the author does not limit herself to critical references from the field of Educational Technology. Her perspective is also informed by didactics, teacher studies, professional development, and extends into sociology and philosophy. This interdisciplinary approach enriches the proposal, allowing readers to understand how all these variables influence educational actors within a shifting context. The hybridization of the physical and the digital defines the school ecosystem, affecting the individuals within it and, therefore, shaping the construction of meaning. This occurs in parallel with a pervasive digital optimism that fosters various attractions and aversions within a curricular framework increasingly reduced to the imperative of digital fascination.

Yet, the discussion goes beyond technology. The precariousness of teachers' working conditions plays a multiplying role, unfolding in the absence of clear regulation and leading to an endless workload that leaves educators feeling unable to make sense of themselves. This is compounded by dynamics that betray the essence of professional development, dressing it up in «new age» models where personal branding and performance take precedence.

Faced with this reality, teachers often reproduce in the classroom many of the values associated with professional success. Ongoing training lends credibility to this narrative, making it viable through endorsement by educational authorities. This enables a transfer of logics that displace professional knowledge and the research field of didactics. Novelty, acting under a scorched-earth logic, erodes long-established professional knowledge structures. These new responses appear to be the only valid ones, as if there were no other way to face the challenges of teaching. Precarious and vulnerable educators emerge everywhere in an act of survival—not just for themselves. The challenge is no longer about individuality: the focus now is on generating collective fascination, including among students. How do we respond to

such a challenge? As a «maker» teacher? A «gamer»? Analog or resistant?

In conclusion, this is a highly recommended read—a work that can help us rethink the role of professional teacher development today and the paths shaped by current initial and ongoing training policies.

FOR AUTHORS

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Bibliographical citations in the text will appear with the author's surname and year of publication (both in parentheses and separated by a comma). If the author's surname is part of the narrative, only the year is placed in parentheses. To separate authors in the text, as a general rule, quotations should be adapted to Spanish, using "and" instead of "and" or the "&" sign.

Example: Mateos (2001) compared studies carried out by... / ...in a recent study on new technologies in education (Mateos, 2001)... / In 2001, Mateos carried out a study on...

In the case of several authors, they are separated by a comma, the last author is separated by an "and". In the case of two authors, both are always cited. When the work has more than two and less than six authors, all are cited the first time, in the following citations, only the surname of the first author followed by "et al." and the year, unless there is another citation whose abbreviation results in the same way and from the same year, in which case the complete citation will be given. For more than six authors, the first author is cited followed by "et al." and in case of confusion with other references, the subsequent authors are added until they are clearly differentiated.

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Jagannathan, S. (2021). The digital learning opportunity. En S. Jagannathan (Ed.), *Reimagining digital learning for sustainable development: How upskilling, data analytics, and educational technologies close the skills gap* (pp. 17-35). Routledge.

ARTICLES

Valverde-Berrocoso, J., González-Fernández, A., & Acevedo-Borrega, J. (2022). Disinformation and multiliteracy: A systematic review of the literature. *Comunicar*, XXX(70), 97-110. <https://doi.org/10.3916/C70-2022-08>

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