ROUTLEDGE FOCUS

ADVANCES IN INTERDISCIPLINARY RESEARCH

Pioneering Innovations and Sustainable Practices Towards Open Science

Edited by
María Soledad Ramírez-Montoya,
Miguel A. Montoya,
Genaro Zavala-Enríquez,
and Antonio Martínez-Arboleda

ROUTLEDGE Focus

Advances in Interdisciplinary Research

This book explores methodologies and strategies for enhancing educational practices through interdisciplinary research and open science. Featuring global contributions, it shows how integrating diverse disciplines can drive innovation, improve teaching, and tackle modern educational challenges.

The book begins by highlighting the value of interdisciplinary research, technological advancements, and innovative processes for enriching education. It includes theoretical frameworks for frontier research, practical data visualization strategies, and inclusive approaches to diversity in higher education. Readers will find discussions on knowledge transfer for social impact and guidelines for integrating equity, diversity, and inclusion in open education. It also emphasizes academic networking and personal branding, offering insights into fostering collaboration and professional development. This resource highlights both the theoretical and practical benefits of interdisciplinary research and open science.

Valuable for researchers, students, and decision-makers interested in advancing educational research, promoting inclusive practices, and emerging educational technology, this book contributes to the discourse on educational innovation and provides essential tools and concepts for advancing educational research and practice.

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Introduction

Advances in Interdisciplinary Research: Pioneering Innovations and Sustainable Practices Towards Open Science

María Soledad Ramírez-Montoya,
Miguel A. Montoya,
Genaro Zavala Enríquez and
Antonio Martinez-Arboleda

> You yourself must be the change you want to see in the world.
>
> Gandhi

Introduction

Innovation for Sustainable Development

Sustainable development and higher education are inextricably linked. Universities and other higher education institutions play a critical role in equipping graduates with the knowledge, skills, and values necessary to tackle global challenges. This book argues that universities can become powerful engines for sustainable development by fostering interdisciplinary collaboration, promoting innovative teaching and research approaches, and actively engaging students in projects with social and environmental impact.

The Sustainable Development Goals (SDGs) include Goal 4: Ensure inclusive, equitable, and quality education and promote lifelong learning opportunities for all. This objective has spurred far-reaching efforts to implement it worldwide. Higher education for sustainable development seeks to cultivate in students the knowledge, skills, and values needed to contribute to a more sustainable future. This includes integrating the SDGs into curricula and promoting research on issues related to the environment, society, and the economy.

As Zúñiga-Sánchez et al. (2022) point out, although education for sustainable development entails the adoption of principles and practices, "this process is not exempt from tensions between the ways of understanding its scope and application by internal actors in the university". Even if these principles and practices seem to be increasingly disseminated as a social innovation related to environmental education, there remains a lack of understanding about their application in other areas.

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The debate on sustainable growth and development highlights the importance of dialogue, the exchange of best practices, peer review, and coherent, evidence-based policies and strategies to effectively address global inequality and exclusion. Education plays a key role in this process (Visvizi et al., 2018). Central to the debate on sustainable development is the imperative to promote equal opportunities with a focus on diversity and inclusion in higher education. This requires special attention to advancing the worldviews, knowledge, and skills of societies and individuals, enabling them to recognise, leverage, and expand existing opportunities.

Higher education for sustainable development extends beyond initial training or universal access to education; it encompasses lifelong education. Universities could become centres of knowledge and dialogue on the challenges of sustainable development, offering continuing education and training programmes for working professionals. In this way, they contribute to strengthening the capacity of organisations and communities to adopt more sustainable practices. The transfer of knowledge from research is essential to generate social impact, and examples such as interdisciplinary research in educational innovation and academic networks for innovation and research (Ramírez-Montoya & Bartolomé, 2023) contribute to this objective.

In conclusion, higher education is a fundamental pillar for achieving the SDGs. Higher education institutions must assume active leadership in their promotion by encouraging interdisciplinary collaboration, innovation, and student participation in projects with social and environmental impact. As United Nations Educational, Scientific and Cultural Organisation (UNESCO) states, "education is the key to achieving many other sustainable development goals" (UNESCO, n.d.).

Open Science to Promote Equity in Knowledge

Open Science principles and practices promote and articulate collaboration to address complex global challenges and achieve the SDGs, recognising that science transcends national borders and should serve the global good (Lee & Haupt, 2021). Vicente-Saez et al. (2020) identify "transparency and accessibility to science outputs, and authorisation and participation in science production" as key principles of Open Science. The UNESCO Recommendation on Open Science emphasises the values of quality and integrity, collective benefit, equity and fairness, and diversity and inclusiveness in scientific practices (UNESCO, 2023). These values underpin a vision of science as a global public good that should be accessible to and benefit all humanity, challenging traditional, closed science systems that restrict access to research findings, data, and resources and perpetuate knowledge disparities.

However, to fully realise this vision of knowledge equity, Open Science must adopt a process-oriented approach that prioritises meaningful connections and collaborations among diverse individuals and groups (Leonelli, 2023). Weingart et al. (2021) argue that the pervasive use of the

vague term "engagement" in discussions of Open Science is problematic, as the "engagement rhetoric" obscures the tensions between the positive motivations to adopt Open Science approaches and the inconsistencies that arise in practice. Open Science approaches often lack granularity and fail to adequately address the diverse needs and experiences of different publics, which is a crucial practical component of Open Science (UNESCO, 2023).

A more nuanced focus is needed to recognise the various societal actors' types of participation, including the contributions of communities of expertise (Jadallah & Ballard, 2024) and communities of lived experience (Dembele et al., 2024). Open Science must be understood as a process of building relationships and fostering a culture of shared mutual learning and knowledge co-production, rather than merely providing open access to resources (Leonelli, 2023) or complying superficially with official recommendations on engagement without proper operationalisation (Weingart et al., 2021). This redefinition acknowledges the social and situated nature of scientific discovery and emphasises the importance of epistemic diversity and justice in producing reliable and impactful knowledge (Leonelli, 2023).

For this vision of knowledge equity to become a reality, it is necessary to redefine and reimagine professional roles and the structures under which scholars operate, including their incentives, to foster a different culture (Flinders, 2020). This shift towards more equitable partnerships also requires redefining authorship to embrace multi-professionalism in research, valuing the contributions of various university roles (Thibault et al., 2023). Additionally, the intercultural dynamics of global teams and how collaboration is maintained in such contexts must be considered (Dusdal & Powell, 2021).

As demonstrated by Czerwonogora and Rodés (2019), Open Science and Open Education are intrinsically linked. Both fields share values and principles, with practitioners in each learning from one another. Their strategies and methodologies are often mutually beneficial. Integrating Open Educational Practices (OEP) into Open Science practices can foster a more collaborative, effective, and cohesive research and educational landscape. Conversely, there are examples of OEP incorporating Open Research principles (Martínez-Arboleda, 2022).

The effective articulation of civic participation in research is an inherently educational endeavour. It demands that research be conceived not just as a "process of investigation leading to new insights, effectively shared" (REF 2029, 2024) but as an activity requiring an unwavering educational ethos to collaborate, share, learn, and support others' learning before, during, and after its unfolding. Operationalising research participation necessitates educational experts playing a central role, moving beyond creating more accessible research outputs to establishing educational opportunities for meaningful public involvement, as Falk and Dierking (2019) suggest.

This position aligns with the need to foster science literacy among the public, empowering individuals to understand and critically evaluate scientific information (Reddy, 2021) and question dogma (Leonelli, 2023). It also

supports increasing subjective credibility in science (Stracke, 2020) and aspiring to position science as a trusted companion for lifelong learning (Falk & Dierking, 2019). This integrated vision of research and education is crucial for creating a scientifically literate society capable of engaging with complex scientific issues and contributing to knowledge advancement (Reddy, 2021) while promoting the democratisation of knowledge production.

In this vein, the Knowledge Equity Network Declaration represents the first global higher education initiative to integrate Open Education, Open Research, and equity, diversity, and inclusion into a unified agenda for transformation (KEN, n.d.).

Building Together the Future of Education: Innovation, Interdisciplinary Research, and Open Science

The compartmentalisation of science, originating during the Enlightenment, established a structured way of observing reality. However, advances in science, technology, and digital forms of communication have created new social dynamics that demand alternative analyses and perspectives to understand the complexities of the modern world. Persisting with the same methodologies for apprehending reality is insufficient; therefore, disciplines must leave aside their watertight compartments and begin a dialogue "between sciences" to start developing shared methodologies capable of innovatively analysing and evaluating today's social realities.

From this perspective, the present book emerged from a training initiative titled "Bootcamp. Building together the future of education: innovation, interdisciplinary research and open science – Training of Researchers in Educational Innovation and Sustainability". This initiative was convened by two higher education institutions in Mexico and England, a research hub in Spain, and a UNESCO Chair dedicated to Education and Open Science (Figure i.1). The objectives were as follows:

- To share diverse perspectives and challenges in education research at the frontier of knowledge.
- To increase research capacities by incorporating new knowledge and experiences.
- To create interdisciplinary and open networks to build solutions to address the challenges and holistic needs of society.

The **method** was aimed at sharing reflections that would lead to the construction of original research, whether disciplinary or interdisciplinary, with contributions for the future of Education on the frontiers of knowledge of Education, especially in the framework of the SDGs of the United Nations.

The event was conducted in person with online broadcasts in English and Spanish, attracting over 1,000 remote **participants** and 95 academics from 15 countries, including Germany, Brazil, Chile, Colombia, Cuba, El Salvador, Spain,

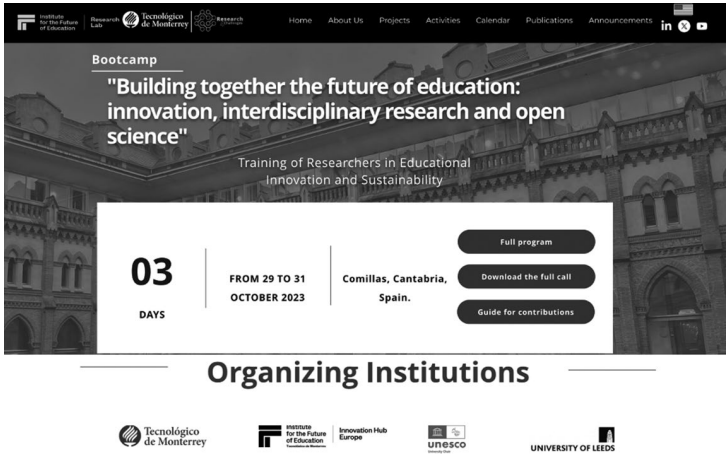

Figure i.1 Webpage Bootcamp: Building together the future of education: innovation, interdisciplinary research and open science. (https://www.research4challenges.world/en/future-education-bootcamp).

Finland, Honduras, Mexico, Peru, Poland, the United Kingdom, the Dominican Republic, and Venezuela, who attended the event held in Comillas, Spain.

The face-to-face participants included experts from Tecnológico de Monterrey, Universidad de Barcelona, Universidad de Salamanca, Universidad de La Laguna, Universidad Complutense, Universidad de Cantabria, Universidad de Granada, the Institute of Educational Technology, Universidad Nacional de Educación a Distancia, Universidad de Sevilla, Manchester Metropolitan University, Universidad Rey Juan Carlos, eScire, Universitat de Barcelona, Centro Universitário Adventista de São Paulo, and Universidad Federal Rural de Pernambuco.

Moreover, the Bootcamp was supported by specialists from 40 institutions: Tecnológico de Monterrey, Universidad de Barcelona, Universidad de Granada, Universidad de Salamanca, Biblioteca Virtual del Sistema Sanitario Público de Andalucía, Universidad Pedagógica Nacional, Centro de Investigaciones Educativas, Universidad Autónoma de Querétaro, Instituto Politécnico Nacional, Facultad de Ciencias de la Salud de Málaga, Universidad de Atacama, Universidad de Guadalajara, Universidad de Ingeniería y Tecnología (UTEC), Peterson Institute for International Economics (PIIE), Universidad César Vallejo, Observatorio de Derechos Humanos, Universidad de la Costa, Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM), Universidad de Huelva, Kozminski University, Liceo Bicentenario de Excelencia Domingo Ortiz de Rozas, Universidad Iberoamericana Puebla, Distrito Sanitario Málaga-Guadalhorce, Universidad Michoacana de San Nicolás de Hidalgo (UMSNH), Pontificia Universidad Católica del Perú, Universidad Católica de El Salvador, Universidad de Málaga, Universidade de Santa Cruz do Sul, Universidad Nacional de Educación a Distancia, University of Leeds,

Universidad Politécnica Territorial Agroindustrial del Tachira, Universidad a Distancia de Madrid (UDIMA), Universidad de La Sabana, Universidad del Rosario, Universitat Oberta de Catalunya, Universidad Tecnológica de la Mixteca, Universidad Católica Nordestana (UCNE), Universidad Ricardo Palma, Universidad San Jorge, and MasQueLearning.

The Bootcamp's materials, tools, and publications are available on the website under open access licenses. In this way, the content of the **Bootcamp programme** provides open educational resources that can support the training of researchers, with Open Education and Open Science practices. The programme's content starting point is to analyse the value that research can have for educational innovation (Ramírez-Montoya & Bartolomé, 2023), the importance of locating the frontier of knowledge in theoretical underpinnings (García-Valcárcel & Vázquez Parra, 2023), building studies with high-level research methods and strategies for interdisciplinary research (Zavala & González-González, 2023), and using advanced technologies to analyse data (Garay-Rondero & Miranda, 2023), as well as making results visible, addressing key points such as diversity and inclusion (Sanabria-Z et al., 2023).

In addition, the programme explored the critical steps for discussing data and formulating conclusions that highlight research contributions, ensuring their societal impact (Buenestado-Fernández & Romero-Rodríguez, 2023). In the construction of research, Open Science for sustainable development (Martínez-Arboleda et al., 2023) and networks in the co-creation of knowledge (Martínez-Pérez & López-Caudana, 2023) stand out. This initiative consistently promoted open practices and effective communication (Herrero & García-Peñalvo, 2023).

Based on reflections conducted before, during, and after the event, the participating experts contributed written chapters to the book *Advances in Interdisciplinary Research: Pioneering Innovations and Sustainable Practices Towards Open Science*. This volume encompasses eight chapters, each offering perspectives on innovation, interdisciplinary research, and openness to collectively envision the future of education and propose new frameworks for the training of educational researchers.

Chapter 1: Focusing on the Differential Value of Interdisciplinary Research from Educational Innovation

María Soledad Ramírez-Montoya and Antonio Bartolomé Pina

This chapter explores the transformative potential of interdisciplinary research in educational innovation to address global challenges. Drawing on an instrumental case study with participants from over 20 countries, the authors identify three key pillars: interdisciplinarity, the generation of novel knowledge, and expanded social impact. These findings redefine the distinctive value of educational research, offering actionable pathways to foster a more inclusive and relevant scientific future.

Chapter 2: Beyond the Frontier: Theoretical Foundations for Interdisciplinary Educational Research at the Frontiers of Knowledge

José Carlos Vázquez Parra, Ana García-Valcárcel Muñoz-Repiso, and Paloma Suárez-Brito

The authors present a theoretical framework for interdisciplinary educational research at the frontiers of knowledge, where science and technology push the boundaries of what is known. By proposing practical models and concrete examples, the authors demonstrate how disciplines can interconnect to overcome epistemological limits. This approach fosters expansive thinking that fuels educational innovation, inspiring readers to rethink collaboration and its transformative scientific potential.

Chapter 3: Data Visualisation Reference Framework in Education 4.0: An Approach for Lifelong Learning for Researchers

Jhonattan Miranda and Claudia Lizette Garay-Rondero

In a data-centric world, this chapter proposes a reference framework for data visualisation aligned with Education 4.0. It emphasises lifelong learning and equips researchers with advanced tools for informed decision-making. This chapter revolutionises the scientific community's engagement with data, paving the way for meaningful, technology-driven learning experiences.

Chapter 4: Attention to Diversity and Inclusion: Effective Strategies in Higher Education

Inés Alvarez-Icaza, Paloma Antón Ares, Pamela Geraldine Olivo, and Jorge Sanabria-Z

This chapter highlights participatory methodologies and strategies for fostering inclusion in higher education. It offers best practices in accessible design, open educational resources, and actionable tools, to ensure equity and universal access. The strategies presented transform educational dynamics while reinforcing a global commitment to fair, inclusive, and diverse learning environments benefitting society as a whole.

Chapter 5: Transferring Research with Discussions and Conclusions of Value for Knowledge with Social Impact

Mariana Buenestado-Fernández and José-María Romero-Rodríguez

Knowledge transfer bridges the gap between research and societal change. This chapter explores how to maximise the impact of scientific findings,

emphasising effective strategies that serve societal benefit. The authors advocate reflective practices that enhance a knowledge-centred economy, inspiring researchers to prioritise collective well-being through their work. This vision underscores the transformative power of research when its reach extends to the broader community.

Chapter 6: Equity, Diversity, and Inclusion in Open Education: Recommendations to Support Researchers and Practitioners

Carina Bossu and Francisco Iniesto

This chapter highlights the need of integrating equity, diversity, and inclusion principles into Open Education practices, promoting practices and resources tailored to the realities of the Global South. The authors present guidelines and insights based on collaborative research, offering a roadmap for inclusive education. This approach strengthens the commitment to openness in education, aligning with global equity and sustainability ideals.

Chapter 7: Academic Networking for Innovation and Research: Fostering Complex Thinking Through the ORLAB Education Platform

Sandra Martínez-Pérez and Edgar Omar López-Caudana

Through academic networks, this chapter illustrates how collaboration drives complex thinking and educational innovation. Using the *OpenResearchLab* platform, the authors highlight the power of academic spaces in fostering shared knowledge. By promoting creativity and effective interaction, this chapter inspires scientific communities to address contemporary challenges through joint efforts and advanced technologies.

Chapter 8: Academic Networks and Personal Branding in the Open Educational Movement

Carmen Herrero, Luis M. Romero-Rodríguez, and Francisco José García-Peñalvo

The authors examine the role of academic networks and personal branding within Open Education. They reveal how virtual communities enrich professional development for educators and researchers, expanding the reach of open educational resources. By advocating for transmedia strategies and inclusive practices, this chapter fosters a sustainable open educational movement where innovation and connection become essential pillars for transforming universities and global societies.

This book integrates forward-thinking perspectives to strengthen the training of today's researchers. It envisions horizons where building relationships among individuals and institutions facilitates practical solutions to global challenges. The contributions emphasise the need to embrace dialogue and relearn how to listen to diverse perspectives shaped by contemporary social realities.

The call to action is clear: to create spaces of solidarity where scientists and researchers collaborate to design community-driven solutions for a fairer and more responsible society. This vision requires eliminating preconceptions and fostering collaborative efforts across societal sectors, leveraging their strengths to address real-world challenges. By embracing openness, solidarity, and interdisciplinary approaches, we can collectively create a better future, echoing Gandhi's words to dream of that future by creating a better present.

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1 Focusing on the Differential Value of Interdisciplinary Research from Educational Innovation

María Soledad Ramírez-Montoya and Antonio Bartolomé Pina

Introduction

Scientific research across diverse disciplines aims to enhance the well-being of individuals and society. This objective must be contextualized within the framework of complexity, where the interconnectedness of various dimensions of reality forms a fabric-like structure composed of multiple layers (Morin, 2011). Ghoshal (2018) emphasizes the intricate relationship between science and society, where the "social value" of research is often interpreted in terms of the moral balance of the research conducted. As complex challenges arise in both present and future educational contexts, interdisciplinary research that incorporates multiple perspectives becomes essential (Ramírez-Montoya et al., 2022). Integrating knowledge from different fields can provide valuable solutions to these challenges.

But what exactly is the value of research? Pérez-Escoda (2017) defines research value as an original and novel contribution to the scientific community that enhances the visibility and effectiveness of academic efforts. Similarly, Pearson (2022) highlights the importance of communicating actionable results that directly align with the needs of users, which suggests that consulting end-users can help target studies to maximize their value (Tunis et al., 2012). The scientific value of studies is closely linked to the objectives established in the research.

Historically, various perspectives on research value have emerged. For instance, Verschuur and Potjer (1975) linked research contributions to market applications, while others emphasized responding to social demands (Spaapen & Sylvain, 1993) or focusing on geographical and linguistic expansion (Anderson-Levitt, 2014). Recently, highlight the importance of new research results such as the number of peer-reviewed publications, citation metrics, and the accessibility of research through Altmetrics (Heyard & Hottenrott, 2021). Given this context, the aim of this chapter is to analyse the voices of researchers through participatory exploration to identify practical

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strategies for highlighting the differential value of educational research. This chapter presents key conceptual frameworks, outlines the methodology, and discusses the results. The study is intended to serve academics, researchers, and decision-makers interested in interdisciplinary research and educational innovation.

Conceptualizing the Value of Research and Its Typologies

Research value is characterized by its differential, unique, and strategic contribution to the development of scientific knowledge and its ability to provide innovative solutions. Grimm et al. (2017) recommend evaluating the anticipated value of research to reduce uncertainty and improve the implementation process, considering expert beliefs and the strength of evidence. Evidence-based research can enhance decision-making (Higuchi & Yamanaka, 2019). It is crucial to build "collective awareness" around the value of research, particularly for those involved in researcher training, education, and development (Vereijken et al., 2018).

Research contributions can be classified into several categories: scientific, social, thematic, educational, political, technological, open value, and sustainable development. In the scientific domain, Gregoris and Shorvon (2013) emphasize the significance of "high lasting value," which is identified through high initial citation rates and publications in high-impact journals. Lairumbi et al. (2008) note that maximizing social value requires collaborative partnerships with policymakers and communities from the outset of research, followed by the dissemination of findings to participants, policymakers, and practitioners once the study is complete. Barber and Luke (2016) advocate for the practical application of research findings, as well as the value of reflective learning for students, highlighting the "thematic value" of research. These scientific, social, and practical applications are interconnected.

Educational, political, technological, open-access, and sustainable development perspectives also contribute to research value. Willinsky (2001) argues for the importance of increasing knowledge accessibility from the educational, political, and technological perspectives to enhance the contribution of educational research to public discourse and deliberative democracy. Open-access initiatives, such as those promoted by Read et al. (2021), advocate for data sharing to improve transparency and the reuse of research data. Openly sharing and citing datasets in publications are highly cited (Belter, 2014) Similarly, Kekecs et al. (2023) emphasize the importance of producing credible research with open data that can be verified by peers. In the field of sustainable development, Pérez-Soba et al. (2018) introduced an open platform that promotes research value by making knowledge operational across the science, policy, and practice communities. Consequently, interdisciplinary studies have a broad impact across various sectors.

Studies on the Value of Interdisciplinary Research

Interdisciplinary research incorporates techniques and processes from multiple disciplines to produce novel insights and applications. For instance, applications of interdisciplinary research have been used in health, psychology, and education to create new processes for engaging people with disabilities in research. Klatt et al. (2003) demonstrated how a brief primer could teach students about the components of a research article, while Vanwormer et al. (2014) recommended incorporating research participation into undergraduate psychology curricula to offer practical experience. Additionally, interdisciplinary research has shown value in marketing, management, and information science, with studies like those by Pallant et al. (2020) highlighting the role of self-selection in research buyers' value assessments.

Technological and innovation value is also a key outcome of interdisciplinary research, which can lead to the development of new organizations and processes (CONAHCYT, 2020):

- Technological Development: Systematic use of knowledge and research directed towards the production of materials, devices, systems, or methods including the design, development, improvement of prototypes, processes, products, services, or organizational models.
- Innovation: Introduction of a new, or significantly improved, product (good or service), process, marketing method, or new organizational method, in the company's internal practices, workplace organization, or external relations.
- Technological Innovation: Innovation that is distinguished by an improvement or novelty in the performance characteristics of products or services, and its applicability in practice will depend on the degree to which such characteristics and their degree of novelty are an important factor in the sales of a company or industry concerned (Oslo Manual).
- Technology-Based Firms: Organizations producing goods and services committed to the design, development, and production of new innovative products and/or manufacturing processes through the systematic application of scientific know-how (Office of Technology Assessment).

In the field of educational innovation, key categories emerge that enable interdisciplinary researchers to explore new frontiers of knowledge. For instance, in technological development, researchers can build on prior knowledge to create new teaching materials, interactive tools, or innovative teaching methods that optimize learning. An interdisciplinary team might design a smart classroom prototype that integrates sensors, artificial intelligence, and data analytics to personalize each student's educational experience, thereby significantly enhancing learning outcomes.

Innovation in education refers to the introduction of novel or improved practices within the educational environment. This could manifest in the implementation of online learning platforms that not only provide educational content but also integrate real-time assessment tools and instant feedback. For example, a researcher might develop a new method for collaborative online teaching that fosters interaction and idea exchange among students from various disciplines, promoting deeper and more meaningful learning experiences.

Technological innovations often involve significant enhancements to the features and performance of educational tools or services. A prime example is the development of educational software that leverages augmented reality (AR) to make abstract concepts—such as mathematics or natural sciences—more tangible and comprehensible. A researcher in this domain could measure how these technological advancements impact student motivation and performance, demonstrating their added value in educational settings.

Technology-based companies in education focus on developing innovative learning tools through the systematic application of scientific and technical knowledge. For instance, a startup could create a mobile app that employs advanced algorithms to customize educational content to each student's unique needs, ensuring personalized and effective learning. Researchers could collaborate with such companies to evaluate the impact of these products across different educational contexts and levels, contributing to the continuous improvement of educational practices.

Focusing on the Differential Value of Educational Research

Educational research employs the scientific method to explore educational processes. When research focuses on educational innovations, it assesses the impact of new products, services, or solutions that integrate novel elements into existing systems, enhancing their functionality and outcomes (Valencia & Valenzuela-González, 2017).

But what value can educational innovation provide? According to Ramírez-Montoya and Lugo-Ocando (2020), educational innovation generates value through the introduction:

- New Process: organization, method, strategy, development, procedure, training, and technique
- New Product: technology, article, instrument, material, device, application, manufacturing, result, object, and prototype
- New Service: attention, provision, assistance, action, function, dependence, and benefit
- New Knowledge: transformation, impact, evolution, cognition, dissent, knowledge, talent, patent, model, and system

Focusing on the differential value of educational research requires a clear understanding of the reasons for conducting the study. This involves providing a well-justified rationale, underpinned by conceptual frameworks, and supporting statistics. By clearly defining the purpose of the research and its potential contributions, researchers can highlight the unique and significant impact their work has on advancing science and improving the well-being of society.

Method

This study utilized an instrumental case study approach, focusing on a group of participants engaged in training for educational innovation research. Stake (2013) defines an instrumental case study as a limited situation or entity used to explore a topic of interest. In this study, the "entity" comprised the group of participants, and the objective was to understand, from their perspective, what differentiates and adds value to research. The guiding question was: How can the differential value of educational innovation research be focused? The aim was to analyse participants' perceptions through a participatory exploration, identifying practical ways to highlight the differential value of educational research.

Stage and Participants

The case study centred on participants of the seminar "Focusing on the Differential Value of Interdisciplinary Research from Educational Innovation," held during the Bootcamp Building the Future of Education Together: Innovation, Interdisciplinary Research, and Open Science: Training of Researchers in Educational Innovation and Sustainability. The seminar covered key themes, such as the value of research in generating knowledge and innovation, the importance of interdisciplinary teams, the integration of technology, and addressing global challenges and sustainable development (Ramírez-Montoya & Bartolome, 2023).

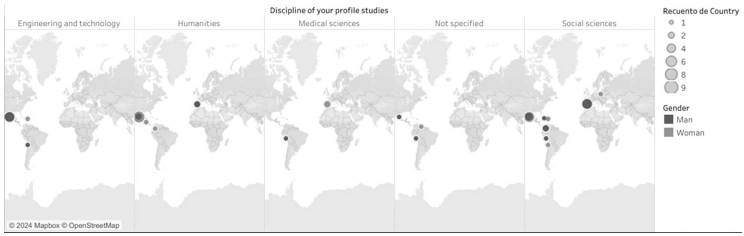

Figure 1.1 In-person participants in the Bootcamp seminar.

Figure 1.2 Online participants in the Bootcamp seminar.

A total of 268 participants took part in the study. Of the 95 in-person participants (Figure 1.1), most were from Social Sciences, Engineering, and Humanities. The 173 online participants (Figure 1.2) shared a similar profile, although they included individuals from Natural Sciences and Medical Sciences, with the latter being represented to a lesser degree.

Analysis

Participants' perceptions were gathered through a questionnaire designed to explore three key questions, using both closed- and open-ended responses. The questions were: How can you provide differential value to your research? (Closed-ended answer options: Working in interdisciplinary teams, Generating new knowledge that serves as a basis for innovation, Integrating technology into design and processes, Investigating from a global perspective); What do you think could be the differential value of your research? (Closed-ended answer options: New knowledge, Process, Product, Knowledge); and What would you rely on to highlight the differential value of your research? (Open-ended response). The data were analysed through cross-referencing the participants' responses to these questions and identifying patterns based on gender.

Ethical Considerations

Participants' data were managed with care and confidentiality. Informed consent was obtained, with participants explicitly informed that their data would be used solely for research purposes. The study adhered to the Ethical Guide for Educational Research set forth by the British Educational Research Association (BERA) (2019), following its standards on consent, care, storage, and data protection. The dissemination of results prioritizes the privacy of all participants.

Results

Based on the analysis of the three closed- and open-ended questions, participants' perceptions revealed the following key insights.

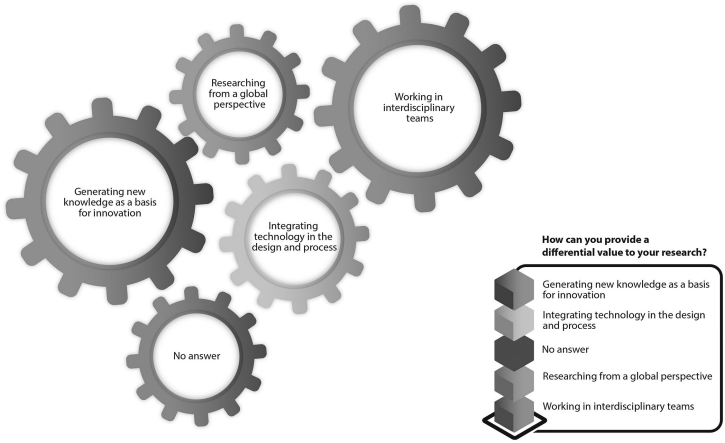

Figure 1.3 Perception of strategies to provide the differential value of research.

How can you provide differential value to your research? Participants recognized the power of interdisciplinary teamwork and the creation of new knowledge as pillars of innovation, followed by the integration of technologies and adopting a global perspective (Figure 1.3).

Collaborating with experts from various disciplines enriches perspectives and enhances creativity, leading to more holistic solutions to complex problems. By generating knowledge that serves as a foundation for future innovations, research provides immediate solutions while also building a legacy that can transform education in the long term.

What do you think could be the differential value of your research? Participants identified the differential value of their research in its ability to generate novel knowledge and develop innovative processes, both fundamental to transforming the educational landscape (Figure 1.4).

By focusing on new insights and methodologies, educational research can better respond to the changing needs of students and society. This approach fosters interdisciplinary and collaborative studies that redefine effectiveness and equity in education globally, inspiring new pedagogical discoveries and transformative practices. Additionally, addressing emerging trajectories to generate new products and services remains crucial for the ongoing transformation of education.

What would you rely on to highlight the differential value of your research? Open-ended responses emphasized the value of multidisciplinary teams and emerging technologies as key factors for strengthening research capacities in education (Figure 1.5).

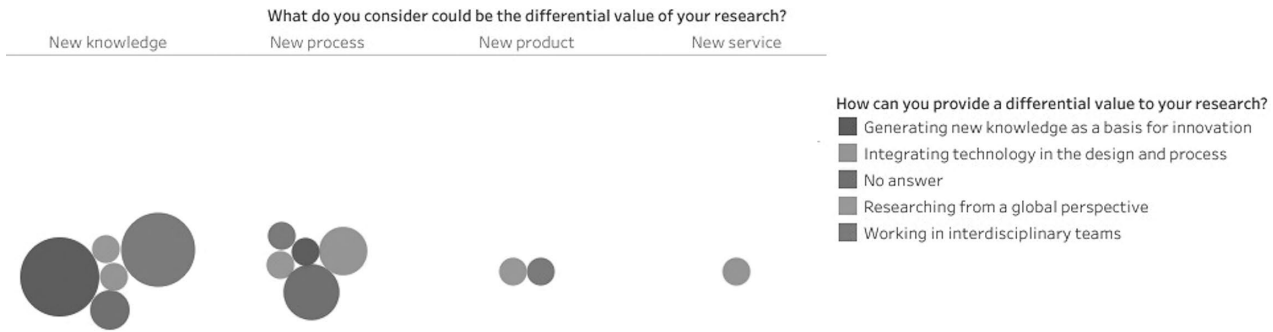

Figure 1.4 Types of value in accordance with the identification of the differential value of the research.

Figure 1.5 Key strategies identified for highlighting differential value of educational research.

These findings suggest that maximizing the impact and differential value of educational research requires developing strategies that integrate interdisciplinary collaboration and advanced technologies, fostering robust research environments responsive to the dynamic needs of the 21st century.

Discussion

Interdisciplinary collaboration is essential for research aimed at addressing global challenges, creating innovative solutions, and contributing significant educational advancements. Figure 1.3 highlights the emphasis on working with diverse disciplinary profiles and generating knowledge as the basis for innovation. This aligns with the perspectives of CONAHCYT (2020), Klatt et al. (2003), and Ramírez-Montoya et al. (2022), who stress the importance of knowledge convergence for expanding developments and innovations. Future research and practice should prioritize interdisciplinary collaboration to establish a strong foundation for integrated and effective educational solutions.

Contributing new knowledge, processes, products, or services will have a greater impact on educational transformation and benefit society. Figure 1.4 shows that participants identified their contributions primarily in knowledge and processes, consistent with Ramírez-Montoya and Lugo-Ocando (2020), who emphasize the role of research in educational innovation. However, the authors also highlight the need for developing new products and services. This suggests that future efforts should focus on fostering research that diversifies its contributions to enhance its transferability to science and society.

Expanding the social value of research requires strategic alliances that foster collaboration with decision-makers, communities, and knowledge transfer initiatives. Figure 1.5 emphasizes the importance of working in teams that amplify research potential. This finding aligns with the work of Barber and Luke (2016) and Lairumbi et al. (2008), who advocate for the promotion of research outcomes and the societal value of findings. Scaling and transferring research results necessitates establishing strong collaborations and strategies for knowledge dissemination and social engagement to maximize future research impact.

Conclusions

Research aims to generate knowledge and provide solutions, and in an increasingly complex society, studies that transcend borders are essential. This study addressed the question: How can the differential value of educational innovation research be focused? The findings indicate that participants recognized the differential value in generating new knowledge and processes, emphasizing interdisciplinary teamwork as the foundation for innovation. Strategic alliances were also seen as crucial for supporting and maximizing differential

value. The key factors for focusing on differential value are: (a) working interdisciplinarily to address global problems; (b) promoting new knowledge, processes, products, or services; and (c) expanding social value by engaging decision-makers, communities, and users. To advance educational innovation, research must transcend its limits and focus on transferring its value to society.

The implications for educational practice include emphasizing the importance of identifying the differential value of research contributions, promoting research-based learning strategies, fostering interdisciplinary collaboration, analysing statistical databases that highlight challenges, and employing challenge-based learning to address global issues. Research implications include employing mixed methodologies that increase scientific knowledge through differentiated strategies, seeking knowledge frontiers, and producing original data.

The study's limitations stem from its focus on a specific training scenario, which may not be generalizable due to its limited scope. However, the diverse disciplinary profiles and geographic contexts of the participants provide valuable insights into perceptions from various settings. Future studies should explore multiple cases, mixed methods approach, and varied instruments across different regions. This research invites further exploration into the differential value of research, a driving force for advancing science and benefiting society.

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2 Beyond the Frontier

Theoretical Foundations for Interdisciplinary Educational Research at the Frontiers of Knowledge

José Carlos Vázquez-Parra, Ana García-Valcárcel Muñoz-Repiso and Paloma Suárez-Brito

Introduction

Frontier research refers to those studies that identify, describe, or analyse scientific or technological knowledge that is at the very limit of current understanding. Such research seeks to respond to original questions that are not always answered exhaustively in areas that are little explored within a discipline. This type of investigation often delves into uncharted territories, pushing the boundaries of what is known and challenging existing theories or models. By exploring these peripheral areas, frontier research contributes to the expansion of the collective knowledge base and opens up new avenues for further inquiry. In this sense, frontier research is usually innovative and avant-garde, where researchers make proposals that challenge the establishment with the intention of expanding the limits of knowledge. These proposals often involve unconventional methodologies or theoretical frameworks that question the status quo. Researchers engaged in frontier research are not afraid to take intellectual risks, and their work frequently leads to paradigm shifts or the development of entirely new subfields within a discipline. The avant-garde nature of this research means that it can face scepticism or resistance from traditionalists, but it is precisely this challenging of established norms that drive scientific and technological progress.

It is not surprising that frontier research is developed from mixed disciplinary perspectives, seeking to address complex problems or challenges in an integrated way, considering collaboration between different fields of knowledge. Interdisciplinary collaboration allows for the combination of diverse expertise and viewpoints, which is essential when tackling multifaceted issues that cannot be fully understood through a single disciplinary lens. By integrating methods and concepts from various disciplines, researchers can develop more holistic approaches to problem-solving. This synergy enhances the

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potential for innovative outcomes and can lead to breakthroughs that might not be achievable within the confines of a single discipline. Consequently, frontier research opens vast possibilities for investigation, urging scholars to go beyond what they know about the subject within their discipline, experience, or area of expertise. It encourages a culture of continuous learning and intellectual curiosity, where researchers are motivated to explore unfamiliar territories and adopt new perspectives. This expansion beyond traditional boundaries not only enriches the researchers' own understanding but also contributes to the advancement of their fields by introducing fresh ideas and approaches. The collaborative nature of frontier research also fosters the development of networks and communities of scholars who are collectively engaged in pushing the frontiers of knowledge.

This chapter proposes a reference framework on frontier research in educational innovation, paying particular attention to the relevance of interdisciplinary reflection and the construction of collaborative networks. The objective is to propose a model for promoting research between disciplines, intending to go beyond the limits of pre-established educational paradigms.

Theoretical Framework

Interdisciplinarity in scientific research is a requirement to address problems in all their complexity since the different areas of knowledge provide specific, peculiar, and complementary views on the reality studied. At the same time, creativity is encouraged by opening the range of possibilities in the approach to topics, analyses, and possible interpretations and explanations. The collaborative work experiences in multidisciplinary teams show that the possibilities of relating concepts and ideas in different ways and finding novel solutions to the problems investigated are multiplied.

From this perspective, as Acosta (2016, p. 149) points out, "the university today is facing the challenge of transforming itself or losing legitimacy, social space…," and one facet of this transformation should consist of assuming greater epistemological pluralism to address problems in all their complexity and to be able to generate processes of transformation of reality. It is necessary to transcend a reductionist and fragmented vision of science to assume a much more integrative and innovation-focused approach (Barzaga et al., 2019; Klein & Spychalska-Wojtkiewicz, 2020; Lanhoso & Coelho, 2021; Marín-González & Alfaro, 2021; Marín, 2023) by promoting frontier research and taking risks to go beyond what is established and expected. Likewise, scientific research requires networking that encourages collaboration instead of competition, sharing skills, avoiding segregation, promoting discussion over confrontation, stimulating initiative and creativity, seeking collective rather than individual recognition, and appreciating dissent in the face of consensus raised without debate (Saeteros, 2018).

A very relevant example of this interdisciplinarity can be found in the suggestions offered by biology for the development of technologies, which has led to the development of the field of biotechnology (genetic engineering, synthetic biology, medical biotechnology, etc.) and vice versa; technology also expands the possibilities of biology, as biochemist David Baker points out in a recently published article (Dominguez, 2023), in which he states: "We have created a technology that takes us beyond the possibilities of biology", referring to artificial intelligence systems that make it possible to design molecular machines from scratch to create new drugs, fuels, or unimaginable materials. We can also observe how interdisciplinarity between educational sciences, communication sciences, computer sciences, and telematics, among others, has allowed the development of the vital field of educational technology, focused on instructional design through digital technologies, the development of open educational materials, etc. These examples are just a few pieces of evidence that interdisciplinarity brings numerous benefits to the construction of science and innovation, integrating fields of knowledge to address complex problems and propose innovative solutions (Christensen et al., 2021; Klein & Falk-Krzesinski, 2017; Lettry & Echegaray, 2020).

In this sense, university institutes, observatories on relevant problems, professional networks, scientific associations, virtual communities, etc., are academic and social structures that allow the incorporation of diverse experts for the analysis of complex problems and the search for solutions through research. An example of these networks that have emerged in the Spanish context in the field of education would be REUNI+D (University Network for Educational Research and Innovation) and RETINDE (Transdisciplinary Network for Educational Research), where professionals from different geographical locations and different fields of Education are integrated to carry out joint research projects with a very positive balance (García-Valcárcel & Basilotta, 2021). Specifically, one of the products of the REUNI+D network has been a publication called "Paths and drifts for other educational and social research" (Sancho et al., 2020), in which the influence of ethnographic, historical, artistic, and literary research methods on the suggested educational research methods, related to posthumanist approaches, can be confirmed.

However, we must not forget that building from heterogeneity is an arduous task where theoretical and methodological contradictions generate tensions (López, 2015). Participation in interdisciplinary networks is not always easy; it poses challenges for all participants due to the diverse epistemological, conceptual, and methodological approaches that specialists from different disciplines bring, as well as possible resistance to change. Nevertheless, overcoming these challenges and achieving results is always rewarding, as it allows us to surpass what would be possible without this approach, thanks to the complementarity of researchers' knowledge.

In the light of this, it is worthwhile to analyse the conditions required for interdisciplinary research teams to be effective. First, they should establish open communication based on mutual respect and share clear, well-defined objectives. Embracing disciplinary diversity is crucial; teams should consist of members with different skills, perspectives, and knowledge to enrich the collaborative process. Effective communication is essential, with team members articulating their ideas clearly and overcoming the technical jargon of their respective disciplines to ensure mutual understanding.

Flexibility is another key characteristic, as participants need to adapt to different ways of thinking and problem-solving, demonstrating a willingness to adjust their approaches and strategies when necessary. A commitment to open collaboration fosters an environment where members actively share resources and data, enhancing the collective capacity to address complex issues. Institutional support plays a significant role by providing necessary funding, dedicated time, and recognition of achievements, all of which contribute to sustaining the team's efforts.

Finally, an emphasis on evaluation and learning is vital for continuous improvement. Teams should learn from their experiences, identifying areas for enhancement and implementing necessary changes. Assessing the impact of their work and the progress made in solving problems not only validates their efforts but also informs future initiatives. By cultivating these conditions, interdisciplinary research teams can effectively navigate inherent challenges and achieve meaningful advancements.

Along these lines, Morín (2007) and López (2015) recognize the complexity of thinking to address interdisciplinarity and analyse interdisciplinary construction in praxis from the perspective of Community Social Psychology. In his analysis of how interdisciplinarity is built in praxis, López highlights essential elements for working with others: flexibility, uncertainty, movement in the key in transformation, openness, and dialogue, interdisciplinary construction requires active listening that approaches the phenomenon intended to be known, integrating the dimension of reflection, subjectivity, and the assumptions that cross the researcher himself. Therefore, researchers must consider how to achieve these conditions to carry out effective interdisciplinary work based on collaborative networks that allow progress in frontier research. In conclusion, it should be taken into account that research funding bodies, in conjunction with academia, promote and highly value interdisciplinarity as a necessary strategy to address the complex problems posed by reality. They encourage this practice when forming research teams so that they can respond to the challenges facing humanity and the planet.

Interdisciplinarity Model in Educational Innovation Research

Considering all the above, the Interdisciplinarity Model in Educational Innovation Research (MIIIE) model helps in the process of interdisciplinary

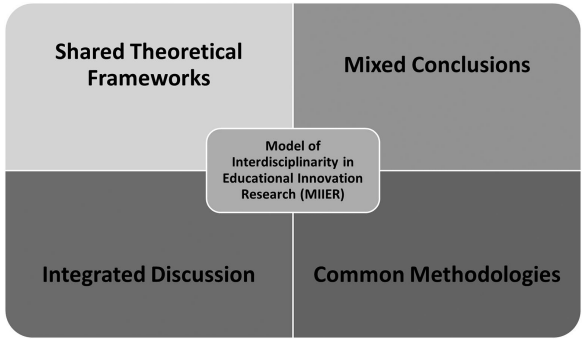

Figure 2.1 Interdisciplinarity model in educational innovation research (MIIIE).

adoption in frontier educational innovation research. This model raises the need for four key elements that all frontier research must consider (Figure 2.1).

a **Shared theoretical frameworks**: The theoretical framework of interdisciplinary frontier research is a crucial element, mainly because it is from this framework that the intellectual and conceptual context necessary to situate research at the limits of the knowledge of two or more disciplines is proposed. In this sense, the theoretical framework should consider four aspects: (a) an introduction that describes the importance and relationship of the topic with previous advances in various fields of knowledge; (b) an exhaustive review of the relevant literature from different disciplines identifying gaps in existing research, as well as relevant theories, approaches, and concepts and how these have been applied in previous studies; (c) an approach to what are the trends marked by recent research in the frontier area, considering new theories, models, or approaches that could be applied in research; and (d) use of references from relevant and current academic sources of both disciplines.

b **Common methodologies:** It is necessary to delve into the different methodologies of analysis used from the disciplines being considered for research, and hypotheses and research questions that can be answered from one of these methodological proposals must be raised. Frontier studies require clear guidance that reflects the relationship between the various disciplines involved, as well as how this is grounded in the theoretical framework and the specific objectives of the research in a novel way. Based on this, adopting a methodology that aligns with the research and the disciplines that converge is relevant.

c **Integrated discussion**: A focal point of all frontier research is the interpretation, analysis, or discussion of the results, considering the possible implications of the research and how this could contribute to advancing the different fields of knowledge beyond what has been achieved so far.

The discussion must highlight the originality and novelty of the approach, the methodology adopted, and the results obtained, as well as how this can fill gaps identified in the interdisciplinary academic literature to transcend the current frontier of both disciplines or between them.

d **Mixed conclusions:** Unlike the conclusion reached in a simple investigation, interdisciplinary frontier research requires that the conclusions not only respond to the proposed objective but also from the different fields of knowledge being considered. In addition, the possible limitations of the proposed interaction between disciplines must be recognized, proposing areas of opportunity for future joint studies or from each area of knowledge. The Conclusions section should show that the challenges posed by this type of research at the edge of knowledge are understood, as well as the complexity associated with any topic analysed at the edge of their knowledge. Finally, it will be a priority that the conclusion is precise in the transcended frontiers since this type of research is the primary objective.

SEL4C. Proposal for Educational Innovation at the Frontier of Knowledge

SEL4C: Social Entrepreneurship Learning 4 Complexity is an educational innovation methodology that aims to develop social entrepreneurship skills and complex thinking through a social entrepreneurship ideation process. It is considered interdisciplinary frontier research that combines knowledge associated with business and education to construct a common methodology, which associates the acquisition and development of transversal competencies with the business profile of social entrepreneurs. Beyond being a methodology that seeks to develop entrepreneurial projects, SEL4C focuses on developing entrepreneurial skills and competencies, generating novel and little-explored results.

a **Theoretical framework**: SEL4C has been built from an interdisciplinary theoretical framework, seeking to collect relevant, updated, and valuable information from both business and education, taking entrepreneurship training as a common element. As an obligatory step, exhaustive research was conducted to appreciate the academic reality of the approach through a bibliometric analysis that yielded data that put this proposal in a little-explored area. By September 2022, only 33 studies associated social entrepreneurship with complex thinking, and none made a concrete methodological proposal (Vázquez-Parra et al., 2022). Thus, a theoretical framework argued the area of opportunity that the development of SEL4C implied, placing its contributions at the limit of joint knowledge of entrepreneurship training and the acquisition and development of complex thinking.

b **Methodology**: To respond to both disciplines, SEL4C adopted the development of a shared methodology, considering the evaluation of competencies

and sub-competencies of entrepreneurship, as well as education. On the part of the business area, the proposal of the Social Entrepreneur Profile proposed by García-González and Ramírez-Montoya (2019) was adopted; in it, as part of the training of the social entrepreneur, it is necessary to develop four sub-competencies: Self-Control, Leadership, Social Awareness and Value, and Social Innovation and Financial Sustainability. On the other hand, educational theory's implications concerning the development of complex thinking structured from four types of thinking: Critical, Systemic, Scientific, and Innovative or Creative. Based on this, a team of specialists in instructional and methodological design analysed the way to propose a set of activities that would combine the acquisition and development of all these elements in a mixed way, with the intention that, when implemented, this methodology could reflect reliable and equitable results in both competencies. After several tests and a process of quantitative, theoretical, and expert validation (Vázquez-Parra et al., 2023), it was possible to have an applicable version of SEL4C, which is not only a valuable proposal for the process of ideation of social entrepreneurship and the development of social entrepreneurship and complex thinking competencies but also contributes academically to the knowledge that is currently available on the relationship between social entrepreneurship and the development of transversal and interdisciplinary competencies and skills valuable for lifelong learning.

c **Discussion of the results of SEL4C implementation**: A decisive point when analysing the results of the implementations conducted is specifying how SEL4C is a methodology that contributes to both disciplines, both theoretically and academically, as well as in the practical field of training. While the formation of transversal competencies is a little explored frontier for businesses, education has done little research on how complex thinking can be developed as part of disciplinary training processes.

d **Conclusions**: In general, the studies carried out from the implementation of SEL4C have identified that there is still a wide area of opportunity in terms of the study of complex thinking, the ways to develop it, and the implications that this can have on the development of comprehensive professional profiles. In this sense, the challenge involved in managing the limit of knowledge and the responsibility of seeking to go beyond the frontier in each step taken in developing the methodology and its new implementations is understood.

Conclusions

Frontier research in educational innovation is essential to drive change and continuous improvement in education. It challenges researchers to contribute meaningfully to designing novel solutions that enrich the learning experience and benefit students, teachers, and society as a whole.

By pushing the boundaries of conventional educational practices, frontier research encourages the development of new pedagogical methods, technological tools, and learning environments that can adapt to the evolving needs of learners in a rapidly changing world. In this sense, constructing inter- and transdisciplinary collaboration networks is fundamental to conducting rigorous research that effectively transcends the limits already reached. Such collaboration breaks traditional practices and explores new possibilities to improve the efficiency and quality of education at all levels. Interdisciplinary networks bring together experts from various fields—such as psychology, technology, sociology, and cognitive science—to address complex educational challenges from multiple perspectives. Transdisciplinary approaches go even further by integrating and synthesizing knowledge across disciplines to create new frameworks and methodologies that are not confined to traditional academic boundaries.

The proposal in this chapter is not as exhaustive as it can be; however, it sheds light on the vast possibilities that educational innovation must transcend the limits of knowledge, whether in education or other disciplines and fields of knowledge. By highlighting key areas where frontier research can make a significant impact, the chapter aims to inspire researchers and practitioners to explore uncharted territories in educational innovation. It emphasizes the importance of being open to new ideas, methodologies, and technologies that can revolutionize teaching and learning processes.

Research is overcoming frontiers at every step; it is the work of researchers, in collaboration, to continue exploring and discovering the unknown. This continuous quest for knowledge and improvement is vital for the advancement of education and society. Collaborative efforts among researchers lead to the generation of new insights, the validation of innovative concepts, and the dissemination of findings that can influence educational policies and practices globally.

By embracing the challenges of frontier research, educators and researchers contribute to a dynamic and progressive educational landscape that prepares learners for the complexities of the future. Furthermore, engaging in frontier research requires a commitment to ongoing learning and adaptability. Researchers must be willing to question established norms, embrace uncertainty, and remain open to interdisciplinary influences. This mindset fosters a culture of innovation where creative solutions can emerge to address the multifaceted challenges facing education today. By investing in frontier research and fostering collaborative networks, we can ensure that education continues to evolve in meaningful ways, ultimately leading to improved outcomes for all stakeholders involved.

In conclusion, while this chapter provides an overview rather than an exhaustive exploration, it underscores the immense potential of educational innovation to push beyond current knowledge boundaries. Whether within education itself or intersecting with other disciplines, frontier research holds

the key to unlocking new possibilities and driving significant advancements. It is through the dedicated and collaborative efforts of researchers that we can continue to explore, discover, and shape the future of education for the betterment of all.

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3 Data Visualisation Reference Framework in Education 4.0

An Approach for Lifelong Learning for Researchers

Jhonattan Miranda and Claudia Lizette Garay-Rondero

Introduction

The evolution of technology and the growing demand for accessible data analysis are closely tied to the history of visualisation tools. From prehistoric cave paintings (Kimwah et al., 2020; Sand et al., 2006) to the Babylonian world map (Iacobucci et al., 2022), images have long been central to human communication. In the 17th and 18th centuries, scientists began using charts and graphs, with Florence Nightingale's Rose Diagram becoming an iconic example in medical statistics (Mardia, 2021). The 20th century introduced software that enabled users to create basic visualisations (Iwasaki et al., 2022), later evolving with 3D tools (Moler & Little, 2020).

By the 21st century, advances in simulations and visualisation tools drove the Industrial Revolution 4.0, where real-time systems collect and analyse vast datasets to solve complex problems (Papadopoulos et al., 2022). These advancements allow organisations to derive insights from big data (Horton, 2022), and with digital platforms, institutions now manage immense volumes of structured and unstructured data (Yang & Ying, 2023). Over the last decade, visualisation tools have evolved rapidly, enabling the presentation of complex data to varied audiences (Ansari et al., 2022; De Haan et al., 2002; Kovacova et al., 2022; Liu et al., 2017; Zvarikova et al., 2022). Researchers now face the challenge of managing big data, which demands updated visualisation skills (Li, 2022; Tiwari, 2022).

Artificial intelligence (AI) and data immersion introduce new challenges in communicating data. This research addresses the question (RQ): What are the most effective tools to visualise data analysis in a timely and efficient way for target audiences? The study explores Education 4.0 and the lifelong learning trend for researchers. It then presents a reference model to guide data visualisation decisions, alongside a chatbot tool for personalised recommendations. A case study evaluates the tool's impact on academics, PhD

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students, and scientists. Finally, the chapter discusses limitations and future recommendations for enhancing data delivery.

The Trend of Lifelong Learning in Today's Education

Within national and transnational education policies, "Lifelong Learning" is a comprehensive umbrella term spanning various learning and educational contexts throughout adulthood. This encompassing framework includes formal, non-formal, and informal modes of learning and education (Thwe & Kálmán, 2023).

One of the main differences between lifelong learning and traditional teaching is that this type of learning is voluntary and optional in most cases. Lifelong learning is a broad term with many definitions and shared meanings and has been interpreted by organisations such as United Nations Educational, Scientific and Cultural Organisation (UNESCO), the Organization for Economic Cooperation and Development (OECD), and the European Commission (García-Bullé, 2018). The abbreviated meaning of lifelong learning is to explain it as an education that occurs both during and after obtaining a degree. Lifelong learning encompasses all learning activities within an individual's educational journey to increase knowledge and improve personal, civic, social, and employability capabilities.

The trend of lifelong learning in education has emerged in response to changes in the labour market and the need to update specific skills and knowledge. Under current labour market conditions, workers must be able to perform new tasks and operate equipment based on the latest technologies (McCoshan & Markowitsch, 2022). As lifelong learning emerges as a predominant educational trend, encouraging individuals to continually undergo training within and beyond formal educational structures to acquire knowledge, skills, and competencies has spurred the development of alternative credentials and micro-credentials.

This work aims to offer an alternative for lifelong learning in the research context; for this, it is necessary to enable educational resources to be aligned with the challenges and needs that researchers in training and experienced researchers have.

Challenges in Lifelong Learning for Researchers

Lifelong learning in professional life is essential to develop critical thinking competencies to solve problems and stimulate creativity and innovation that translates into knowledge generation and materialises in scientific products (OECD, 2012). Therefore, to stay abreast of the current challenges and trends in society, researchers and scientists must continue to update their competencies and knowledge in their respective research fields. Therefore, by acquiring new competencies and expertise, future researchers and experienced

researchers can improve their ability to address research problems and advance their professional careers, considering new knowledge and contemporary tools (Fazal & Chakravarty, 2021).

However, some aspects limit researchers' adequate access to these lifelong learning programs. In this work, the authors address the need to provide training around the competencies that must be developed around communication, specifically about making decisions and selecting the best techniques and technologies for data visualization and research results. The results suggest training issues and needs and provide the necessary resources and frameworks that support these processes.

According to Miranda et al. (2023), three main challenges arise for researchers around lifelong learning (Miranda et al., 2023). Firstly, there is the challenge of providing access to lifelong learning programs that are current, flexible, varied, and accessible at various times and places. This involves coordination between the institute and researchers to find areas of focus and areas of opportunity where required to enable training programs. Secondly, there is the challenge of having access to technological platforms and the development of educational resources that include the necessary topics of interest to researchers. Finally, the challenge of coordinating academic, administrative, and research activities is that many researchers must find moments to carry out training processes. Therefore, in this work, we propose the development of a novel educational product in the field of data visualisation designed to address current needs and challenges in lifelong learning. This product is designed to meet the lifelong learning needs of researchers in training and experienced researchers, offering valuable resources for their continued growth and development.

Methodology

In this work, the authors conduct a literature review using a qualitative research method to analyse current works related to "Education 4.0" and current "Technologies for Data Visualization." The objective is to identify the existing categorisation of these tools and examine how they are currently used, including training programs.

For this analysis, documents found in the Scopus database were considered. Since 2019, 1,514 records have been found with the word "Data Visualization" as part of the titles of published works, mostly describing new techniques and emerging technologies in data visualisation for various fields of knowledge. However, for this study, it was necessary to consider only works that emphasise "Techniques" with implementations of "Technologies 4.0." The inclusion criteria consider publications between 2019 and 2023 in English, conference proceedings, journal articles, and books. The search string used was ("Data Visualization" OR "Data Visualisation") AND

("Technologies" OR "4.0 Technologies" OR "Industry 4.0 Technologies") in their titles, abstracts or keywords. Forty documents were identified, of which three were found to have a relevant focus on education. However, the articles generally present innovations and new visualisation techniques for various fields of knowledge. Therefore, different categorisations of the current techniques and technologies used for data visualisation can be found in the literature (Gough & Zhao, 2023; Miranda et al., 2023; Wilke 2019). These categories may vary depending on the purpose, the focus of the research project, the type of document or platform where it will be displayed, the audience to which it is directed, and the level of reliability desired to be shown.

After conducting this literature review, the authors identified five elements that improve decision-making when selecting the appropriate data visualisation technique and representation of research results. Additionally, it was determined that each method can be associated with a current technology as an enabler and facilitator to obtain the target graphic representation. Table 3.1 concisely summarises the five critical elements proposed for decision-making.

The connection between existing visualisation techniques and current and emerging technologies also suggests the importance of staying updated with the available technological tools and platforms. This may include using specific software, cloud platforms, digital tools, virtual tools, AI, or any other emerging technology to enhance data visualisation.

The synthesis of a literature review, current practices, tools, and technologies that can be used for various data visualisation applications, according to whether it will be relevant for the analyst to note – comparison, relationship, causality, composition, or distribution of data (Abela, 2016), is one of the main contributions of the framework in Table 3.1.

Common Mistakes

In addition to the proposed reference framework, addressing common errors affecting the integrity and effectiveness of the information sought to be represented is imperative in data visualisation. Below are some common mistakes that have been identified which should be avoided:

- *Data overload.* Excessive information inclusion can overwhelm the viewer, making it difficult to identify patterns and draw meaningful conclusions.
- *Disproportion on scales.* Representing data on inappropriate scales distorts visual perception, leading to incorrect and biased interpretations.
- *Wrong charts.* Choosing the wrong chart types can make data difficult to understand and lead to erroneous interpretations.
- *Data overlay.* Excessive overlapping of visual elements can confuse interpretation, making distinguishing between different datasets difficult.

Table 3.1 Reference Framework for Data Visualization

Category/Answers	*Answer A*	*Answer B*	*Answer C*	*Answer D*	*Answer E*
1 What focus do your research results have?	Quantitative	Quantitative	Mixed	Theoretical or conceptual models	Other
2 What format or type of document do you require?	Scientific article	White paper	Technical report	Presentation	Social networks
3 What purpose does visualisation have to present?	Process	To compare, contrast, or show a change	To establish relationships	To show distributions	It is a product or a service
4 What type of audience is it aimed at?	Academic	Scientific	Business	General public	Other
5 What kind of precision do you need to represent?	High	Medium	Low	Minimum or symbolic	Other

- *Application of inappropriate visualisation techniques.* Misusing visualisation techniques for the dataset can distort perception and reduce communicative effectiveness.

Recommendations

This study also identifies best practices inherent in the data visualisation process. The following essential recommendations are derived from these findings.

i The literature consistently emphasises that compelling data visualisations often exhibit simplicity. Overloaded or complex designs are discouraged as they may confuse or overwhelm the audience.
ii Scholarly sources underscore the importance of ensuring that every data visualisation conveys a clear message or narrates a story. The visualisation should serve to reinforce the intended message without introducing distractions.
iii Best practices identified in the literature suggest that interactivity enhances data visualisations by allowing viewers to engage with and explore the presented data actively. Incorporating interactive elements is encouraged for increased audience engagement.
iv Finally, insights from the literature stress the decisive role of colour in data visualisation. However, it is consistently highlighted that its use should be reasonable, focusing on highlighting essential data points or grouping related information while avoiding excessive or hard-to-distinguish colours.

Process Design and Development of the Data Visualisation 4.0 Framework

The analysis indicates that developing a tool to recommend optimal data visualisation techniques and provide insights for effective implementation is feasible. Using the Education 4.0 Reference Framework (Horton, 2022), this tool was designed as an "educational product entity," encompassing products, processes, and infrastructure.

The design process follows four stages: (i) Ideation, (ii) Basic Development to define technical characteristics, (iii) Advanced Development to integrate technological elements, and (iv) Launching to produce prototypes ready for testing. Figure 3.1 outlines this framework (Miranda et al., 2021).

The "digital visualisation tool" aims to enhance the training of researchers in both formal education and lifelong learning. The design incorporates essential elements such as (i) interactivity, (ii) adaptability, (iii) online connectivity, and (iv) accessibility, along with Education 4.0-specific features like (a) active

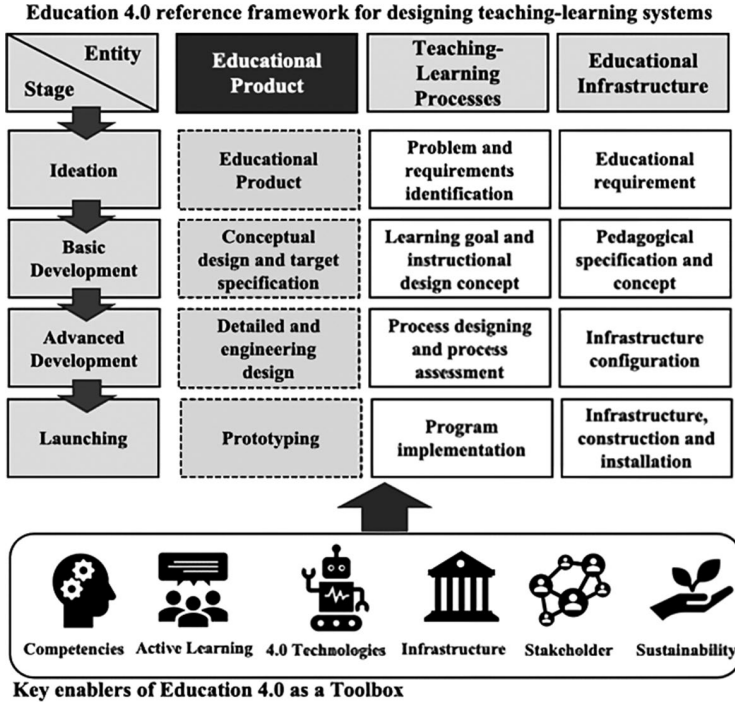

Figure 3.1 Education 4.0 Reference Framework for designing teaching-learning systems through the concept of the educational product entity (Miranda et al., 2021).

learning, (b) Industry 4.0 technologies, (c) classroom/home-based infrastructure, (d) stakeholder interaction, and (e) sustainability. The following sections provide an overview of the key stages in development (see Figure 3.1).

Results

Data Visualisation 4.0 Framework as an Educational Product

The large number of fields of knowledge and the large number of techniques and technologies that exist around data visualisation generate a broad knowledge base so broad that potential users are susceptible to not knowing them and having critical omissions during decision-making about the selection of the best technique and technology to use. In addition to this, there is a challenge regarding the time dedicated to enabling visualisations and knowing how to use emerging technological techniques and tools.

Given this problem, a proposed knowledge base that integrates reference information makes the decision-making process more accessible, and the five critical elements identified in this work are considered.

The proposed solution is based on a data repository processed using AI. Its operation is based on data training using a neural network architecture and generative AI principles. This approach allows users to enter information about the five critical elements mentioned above. AI can generate specific information about the optimal technique and recommended technologies in a personalised way and to the requested field of knowledge.

In addition, the system has been trained with examples, tutorials, and general knowledge in practically all fields of knowledge, thus facilitating decision-making in data visualisation. The proposed didactic tool is intended to be used as an enabler in training processes for future researchers and for lifelong learning processes to update researchers. The latter is because the tool includes updated information. Figure 3.2 presents the operating architecture of the tool proposed in this work.

The implementation was done through a web app that is available online, and a graphical user interface was created where the framework proposed in this work is presented. The graphical user interface includes (i) a main cover of the user interface, where the user is introduced to the tool and general instructions for use are provided; (ii) an initial window with triggering questions, which refer to the reference framework proposed in this work, and which has been conditioned so that the user interacts with the questions and answers; (iii) pathway generation by the set of possible answers, each answer

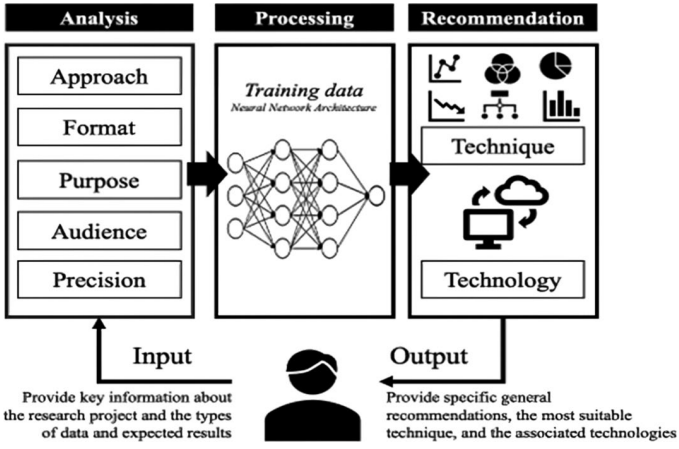

Figure 3.2 Product architecture of the data and result research Data Visualization 4.0 Framework.

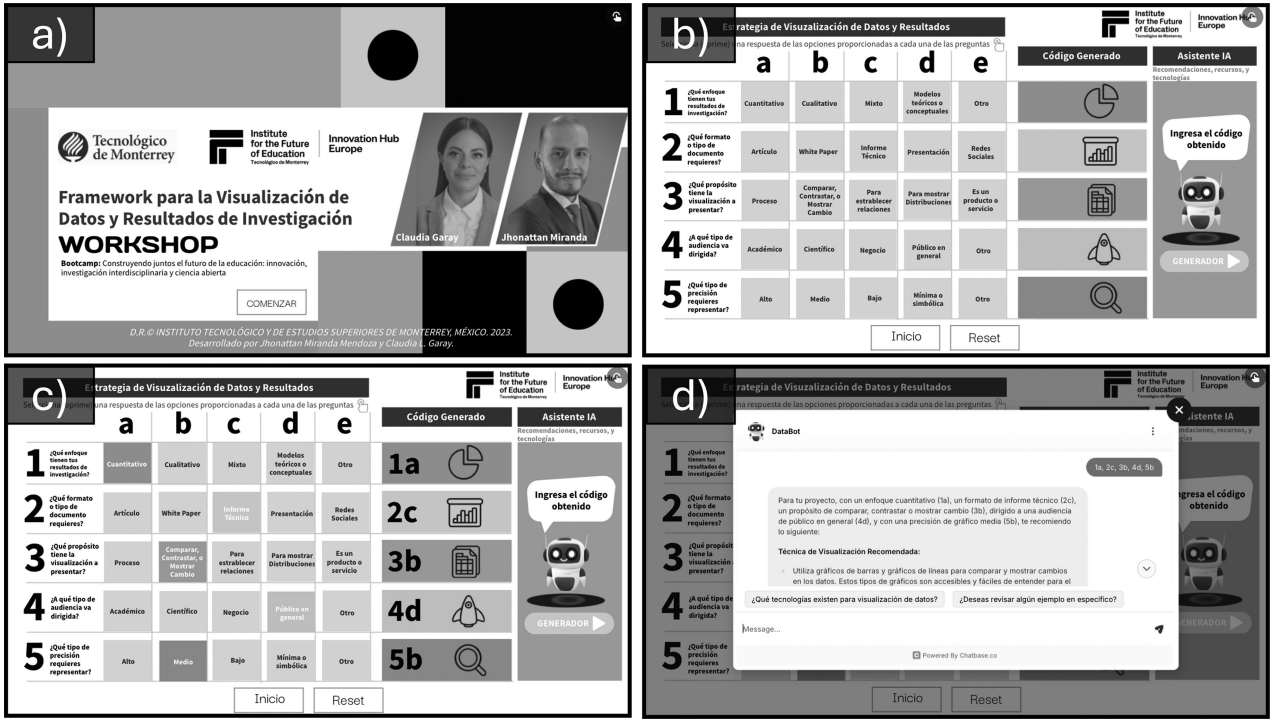

Figure 3.3 Prototype of the Data Visualization 4.0 Framework: (a) Main cover of the user interface, (b) Initial window with triggering questions, (c) Pathway generation by the set of possible answers, and (d) display of the AI window with the result obtained.

of which will be illuminated to generate an assigned code, which must be entered into the generator – AI assistant; (iv) display of the AI window with the obtained result, the space to interact with the AI assistant using a chatbot as the operating principle. The assistant will recommend techniques, technologies, examples, and usage tutorials. Figure 3.3 presents the web app as a new educational product in Education 4.0.

Case Study: The Workshop "Using Technological Tools for Research"

Context: The workshop "Using technological tools for research (interactive session on visualisation of data and research results with technological tools)" was conducted face-to-face for nearly 100 researchers, including graduate students, junior researchers, senior researchers, and almost 600 participants in remote format. The workshop was part of the Bootcamp "Building Together the Future of Education: Innovation, Interdisciplinary Research and Open Science" program (Institute for the Future of Education, 2023). During the seminar, general concepts around data visualisation and representation of results from research projects considered updated information in the field.

Learning objectives: Participants reviewed techniques and technologies for data visualisation and learned to use the technological educational product proposed in this work, "Data Visualisation 4.0 Framework."

Implementation: The workshop lasted one hour, during which the participants who met in person interacted in pairs and used the "Data Visualization 4.0 Framework" tool. In general, reflection is motivated by decision-making in data visualisation.

Results, findings, and discussion: 160 accesses to the web app "Data Visualisation 4.0 Framework" were recorded with 2.9K interactions between the user and the interface. Additionally, an evaluation instrument on user experience and usability was implemented to determine areas of improvement and perceptions of the use of the web app offered.

Two real-time questionnaires, designed in the case study to evaluate the AI assistant, were given to participants during the workshop. The circumstances during the activity didn't allow all the participants to complete the survey. Nevertheless, a sample of 18 responses was obtained for the first survey regarding the problem scenario in the data visualisation, and 4 responses were received for the usability survey.

The first questionnaire describes three questions. Figure 3.4 illustrates that 61% of the audience has considered rethinking how you visualise your data/research results, 33.33% wanted to supplement their research findings, and one person was unsure if they could answer.

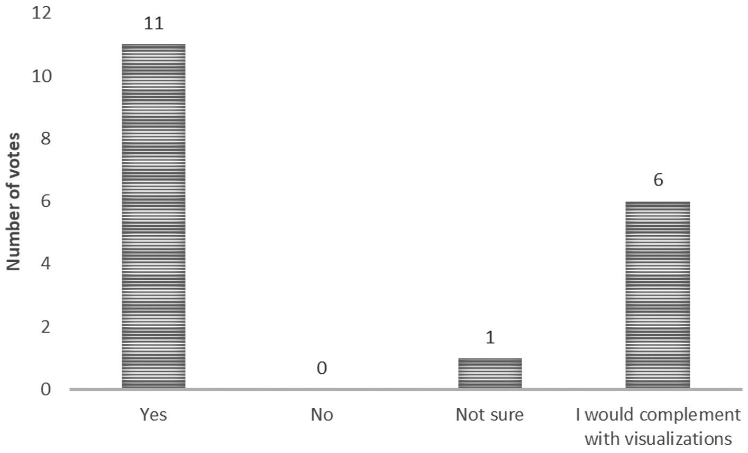

Figure 3.4 Results of question 1, survey 1: Are you considering rethinking how you visualise your data/research results?

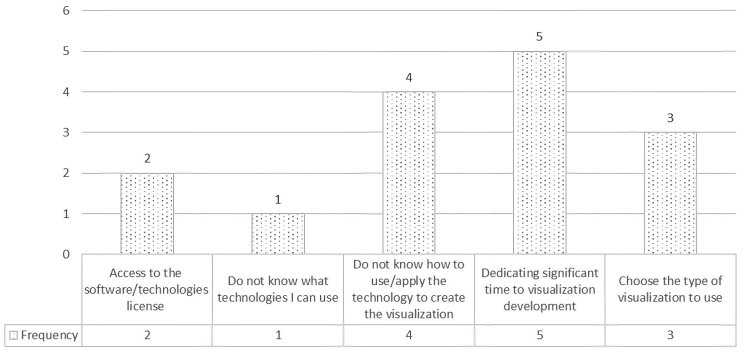

Figure 3.5 Results of question 2, survey 1: What do you consider to be the biggest challenge in achieving proper visualisation of your data/results?

Figure 3.5, following the Pareto rule, has shown that the reason with the most significant weight regarding the challenge of selecting a suitable visualisation for data is "spending more time in the development of the visualisation and not knowing how to use a technology that supports the creation of the correct visualisation."

Finally, when asking the audience for the best strategy for visualising their data/research results massively, the most frequently repeated words were networks, visual, social, charts, NodeXL, tools, and *Tableau* (Figure 3.6).

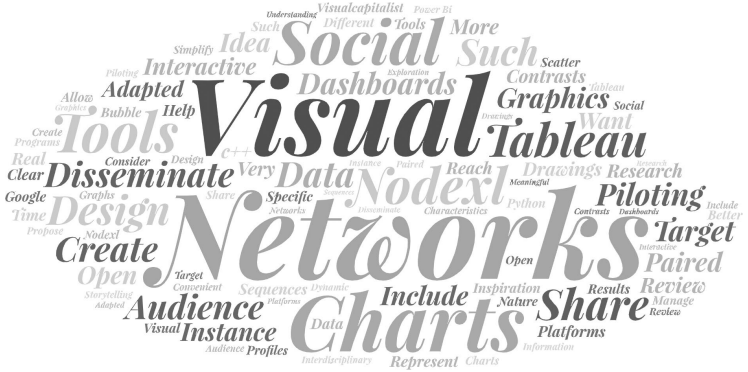

Figure 3.6 Word cloud for question 3, survey 1: What strategy do you propose to visualise your data/research results massively?

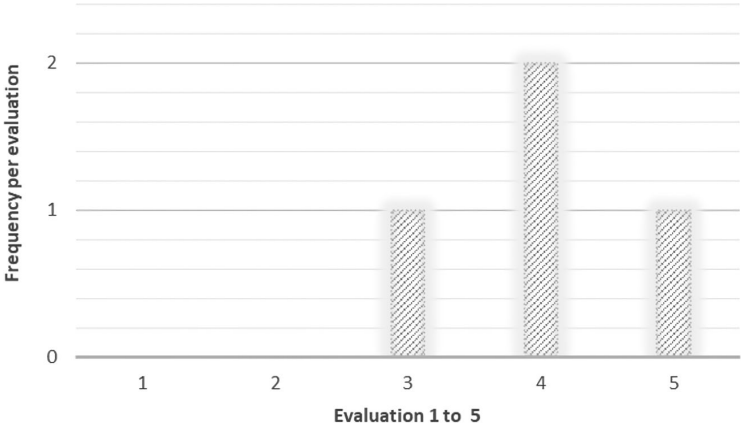

Figure 3.7 User feedback and evaluation for question 1 survey 2: How would you rate the experience and usability of the chatbot framework for data visualisation? 5 is the best score, while 1 is the lowest.

Following the AI assistant (chatbot) user experience, a survey was conducted to gather opinions and suggestions regarding the tool's usability. The findings are displayed below.

Figure 3.7 provides insights into the audience's evaluation, with favourable results and responses up to 3 inclusively. Figure 3.8 shows a polarised response regarding how the tool supports data visualisation development.

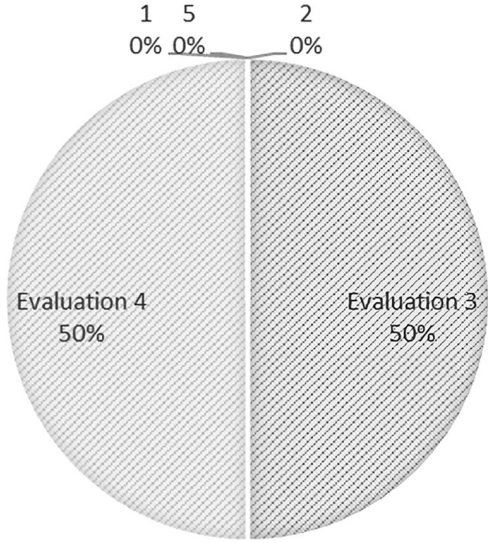

Figure 3.8 User feedback and evaluation for question: How much has the chatbot framework for data visualisation aided you in providing direction for the information presented in your project? 5 is the best score, while 1 is the lowest.

Both surveys suggest the need for a larger sample size and further testing with different audiences.

The final insights came from user comments in response to the survey question: "Please provide suggestions to improve the AI Framework for data visualisation." Feedback included requests for more images and examples, and an emphasis on rigor and accuracy. Comments highlighted the tool's creative potential and value but stressed the importance of comparing outcomes to ensure best practices in data visualisation.

User experience research (Haugeland et al., 2022; White et al., 2022) suggests that building confidence in the tool is essential for continued use, especially through proper guidance and support. It is recommended that users seek input from thesis supervisors, peer mentors, or senior analysts to enhance the application of the tool in scientific research.

Conclusions

Training in data visualisation has often been underestimated and limited to practical experience. However, emerging technologies now challenge researchers to update their skills in digitalisation and become proficient in

new tools. Researchers, data analysts, and decision-makers must navigate these changes to fully leverage data analysis, bridging the gap between domain-specific knowledge and data analytics to derive insights from complex datasets and communicate them effectively.

This study highlights the lack of formal and non-formal programs in data visualisation, despite widespread informal learning. To address this, a "Reference Framework for Data Visualization" and a "Data Visualisation 4.0 Framework" were proposed and validated as technological solutions.

Key contributions include (i) the development of system architecture (Figure 3.2) that can be extended to other solutions; (ii) the synthesis of knowledge through the framework in Table 3.1, helping users select the best data visualisation tools; and (iii) the chatbot tool for supporting digital transformation competencies, aligned with Education 4.0.

These solutions underscore the viability of new educational products for lifelong learning, particularly in areas like researchers' training that are often overlooked. However, the usability test requires a larger sample size, and future research should expand the chatbot's learning capacity and validate the framework with more experts. This approach reflects a major step towards lifelong learning and expanding access to education in this evolving field.

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4 Attention to Diversity and Inclusion

Effective Strategies in Higher Education

Inés Alvarez-Icaza Longoria, Paloma Antón Ares, Pamela Geraldine Olivo Montaño and Jorge Sanabria-Z

Introduction

In the second decade of the millennium, access to education is one of the biggest concerns among policymakers and international agencies. Accordingly, and aligned with Sustainable Development Goal (SDG) 4 concerning inclusive and equitable education (The 2030 Agenda for Sustainable Development, 2015), institutions, civil associations, and governments in joined efforts (Vial, 2019) are in the search for effective strategies to build holistic visions leading to the persistent learning barrier elimination. This chapter offers a collection of good practices on resources, tools, and platforms, taking care of inclusive and accessible educational initiatives, recovered during a workshop at the Bootcamp "Building the Future of Education Together: Innovation, Interdisciplinary Research, and Open Science" in Comillas, Spain, in October 2023.

Design for All (D4A) approach aims to ensure that products are designed for the broadest possible group of people (Persson et al., 2015). In recent years, it has been applied to educational resources and strategies, and its growth has taken place in multiple directions (Grenon et al., 2023) with fruitful results, addressing many barriers, from sensory disabilities and neurodiversity to skills or training gaps. Awareness of the almost impossible task of building one-size-fits-all responses means that the efforts should pursue strategies to build solutions suitable for context, environments, and purposes (Bond et al., 2018). For Education 4.0 (Miranda et al., 2021) strategies, applying technological platforms as content delivery channels demands specific requirements to respond to SDG number 4.

Another popular approach to reaching inclusive and accessible education is the Universal Design for Learning (UDL). The concept stands for creating strategies for teachers, instructional designers, and curriculum specialists to guarantee that all learners, regardless of ability, condition, or context, can benefit from curriculum planning (Cumming & Rose, 2022) and educational

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resources. The UDL takes care of the shape, the channels, and the media used to reach diverse types of learners, focusing on multiple means of representation, expression, action, and engagement (Smith et al., 2019).

Regarding web content accessibility, the Web Content Accessibility Guidelines (WCAG), following a development under the World Wide Web Consortium (W3C) (Web Accessibility Initiative WAI, 2023) process, were created as a cooperative action with individuals and organizations worldwide. Its goal is to provide a unified standard for web content accessibility "that meets the needs of individuals, organizations, and governments internationally." The availability of platforms with WCAG features should ensure a broader reach of digital educational platforms.

This chapter focuses on three key elements that can be used to achieve such a combination. First, we provide information on the regulations, guidelines, and evaluation of Accessible Design and D4A as a fundamental pillar to mitigate and reduce barriers to learning motivated by the digital divide. Second, the development of Open Educational Resources (OER) as projects aligned with accessible content that can be adjusted to the vast diversity of learner types through their lifespan. Third, the focus is on efforts to build suitable channels to facilitate that content, making it accessible but also inclusive (Nieves et al., 2019). The objective is to visualize good practices, observing the three key elements mentioned above gathered from the contexts of the Bootcamp Comillas participants, to offer a collection of alternatives for educators and developers in this relevant matter.

Addressing Digital Accessibility and Inclusion

The technological advances that have been constantly taking place affect the entire population to a greater or lesser extent. Access to Information and Communication Technologies (ICT) generates significant differences in groups that, for different reasons, are disadvantaged in using them, especially people with disabilities vs. functional diversity. Many people are victims of the digital divide. The problems of accessibility lead to many people being info-excluded. To avoid these situations, it is necessary to generalize the D4A that is informed, implement sensitized and aware training plans, and disseminate the importance and need for ICT to be accessible.

Overcoming this digital divide and improving accessibility requires a multi-stakeholder approach involving governments, technology companies, educational institutions, and non-governmental organisations (NGOs). Educational frameworks that encourage the development of accessible technologies must be established. Universal design principles in learning must be integrated into training software developers, designers, and engineers to ensure that accessibility becomes a cornerstone and not an afterthought (UNESCO, 2016).

The approach, also carried out by the European strategy on disability, identifies the following areas of joint action.

- Accessibility: ensuring that people with disabilities have access to goods, services. and assistive devices.
- Participation: ensuring that people with disabilities can exercise all their fundamental rights as European citizens.
- Equality: ensuring the implementation of policies (both at the European Union (EU) and national level) that promote equality.
- Employment: ensuring an increase in the number of workers with disabilities in the labour market and ensure better accessibility to workplaces.
- Education and training: ensuring that students with disabilities benefit from an accessible education system and lifelong learning programs. The European Commission has already launched several initiatives related to education, such as the European Agency for the Development of Special Education.
- Social protection: addressing widespread social challenges experienced by people with disabilities, such as income inequality, risk of poverty, and social exclusion. EU Structural Funds and national measures in EU countries can be used to ensure this social protection.

Educational institutions should be concerned with facilitating the rapid deployment of an ICT infrastructure that is advanced and inclusive, for example, by providing specialized inclusion programs and resources for disadvantaged groups, including those with disabilities.

Open Educational Resources

OER contribute to the digital transformation of higher education. In addition to democratizing access to educational content, adopting and integrating OER fosters innovation in teaching and learning practices and assumes a progressively pivotal position in the digital evolution of higher education. Besides democratizing access to educational content, adopting and integrating OER with new pedagogical models fosters innovation in teaching and learning practices. Indeed, a study focused on Africa highlighted the need for cross-country collaboration to facilitate the adoption of OER, emphasizing its role in ensuring educational equity (Tlili et al., 2022). A second study investigated barriers to OER adoption in higher education, suggesting that meeting these challenges could lead to more extensive and effective use of these digital assets (Menzli et al., 2022). These studies identify the potential of OER to evolve higher education by making it more accessible, equitable, and innovative, thus contributing to its digital transformation.

The design of OER should aim at fostering student empowerment, promoting social justice, and allowing for better integration of diversity in their content (Mncube et al., 2021). However, the adoption and development of OER in educational settings also have negative aspects, such as perpetuating social exclusion by favouring a minority, as pointed out by Ali et al. (2022). Conversely, to improve the use of OER, it is necessary to recognize and address the need for more technical expertise among educators and provide technical support for OER production (Adams, 2021). By overcoming these barriers, OER can help make education available to all, thus contributing to inclusion (Kumar, 2019).

Practices for Inclusion and Access to Educational Content

All e-learning content, open or not, is distributed through digital platforms. Some were developed for educational intentions, and others are used for those intentions, whether they were conceived for different purposes. From YouTube™ channels dedicated to teaching various subjects to LMS (Learning Management Systems) (Abazi-Bexheti et al., 2018), each platform provides its stake to the learning process of its users. Using e-learning technologies is beneficial in increasing efficiency, effectiveness, remote accessibility, alignment, flexibility, and access (Al-Fraihat et al., 2020), all with the possibility of collecting user data. However, it has been a considerable challenge for faculty, learners, and support assistants to adapt those platforms and their functionalities to the capacities of learners with disabilities or neurodiverse conditions (Bong & Chen, 2021). There are many fronts to address diversity, starting with identifying relevant stakeholders.

In this sense, to contribute to improving the learning and living conditions of people at risk of exclusion, calls for Erasmus+ research projects of the European Commission are made, the results of which are available on the Commission's website, accessible, European Commission (2024) and published openly. In the Bootcamp "Building the Future of Education Together: Innovation, Interdisciplinary Research and Open Science" held in Comillas, those that Madrid Association of Early Care (AMPAT) currently has in development, Erasmus+ project aimed at boosting labour inclusion (EMPLOGAME), Digital training for Youth Workers of Independent and non-profit organisations (DISmode), and Development of Advanced Training in Instructional Design of Digital Training, (IMPROINDE), were disclosed, with the aim of promoting collaboration and innovation to generate knowledge and the exchange of good practices. In - Ramírez-Montoya et al. (2021), other projects, already completed, such as Development of effective coping strategies for vet trainers to provide reliable training to learners affected by psychological disorders (DESCA), Supportive training course and self-help groups of parents of youth with physical and learning disabilities on sexual education, techniques and appropriate behaviour (INCLUEDUSEX), and the importance of the improved competences of non-formal adult caregivers of

elderly people with dementia around Europe and our contribution to their training and support (DEMOER), are presented. Training educators is vital to increasing institutional competence in diversifying the channels to deliver learning experiences (Bong & Chen, 2021) following a D4A approach. After the COVID pandemic, we witnessed the emergence of many creative and practical approaches that allow the adaptation of regular –not D4A– OER, responding to the numerous new challenges to face (Almaiah et al., 2020). Nevertheless, some of these efforts, induced by an emergency, lack a long-lasting effect and replicability potential. The unavoidable demands from a community have resulted in the guarantee of universal access to education nudges to create structured and replicable procedures for creating adequate e-learning platforms. While WCAG is the minimum requirement, platforms designed with adaptive learning strategies under the UDL approach and with a user interface design that adapts to the user's capabilities are essential.

Method

The methodology used in this study was participatory research (Creswell & Cresswell, 2018) focusing on inclusiveness and openness during a conference-style Bootcamp event, a conducive environment that allows for open dialogue and collaboration. Participants were the attendees of the Bootcamp session on the subject, which mainly included researchers, professors, and graduate students interested in educational innovation.

The procedure involves three stages in a data collection workshop: (1) contextualization, where the authors provide an introduction to the topic, highlighting the importance of inclusion and open content in educational resources for educational reuse; (2) state of the art, where we present current examples of channels and initiatives that seek to promote inclusive and open resources, marking their pros and cons; and (3) discussion, generating round-table discussions where participants are encouraged to share their opinions regarding the resources presented.

Data is collected through a central participative map generated by the audience by pasting notes on a large template placed on the floor. Their contributions complement this mapping through an online form. The instrument used is the DM4O matrix, which is a tool for the conceptualization process that allows non-experts in accessible design to envision scenarios in which a user interface of an educational platform, in this case, might cause interaction breakdowns to specific profiles of users.

Results

The design of inclusive OER is critical to ensuring universal accessibility and effectiveness of learning for all, regardless of their skills, needs, and circumstances.

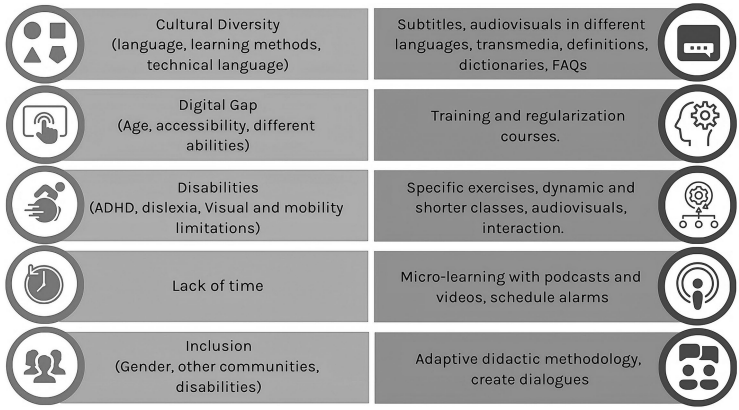

Figure 4.1 Categories of learning barriers and potential solutions identified by the Bootcamp participants.

Given the needs and problems in this study, it is relevant to acknowledge existing initiatives to bridge the gap. The R4C research group from the Institute for the Future of Education at Tecnológico de Monterrey focuses on developing creative educational strategies through the design of digital tools based on the concept of Open Science. One purpose is the design of OER that prioritize inclusion from their conception.

During the Bootcamp in Comillas, we asked participants to identify learning barriers and viable solutions to favour accessibility and inclusion in adult learners. The results, shown in Figure 4.1, can be considered a map that allows us to recognize and evaluate certain elements that favour inclusion and will guide the design of educational digital tools from plurality to inclusion. Based on the consensus among the Bootcamp participants, a series of recommendations have been defined to allow the design of digital educational strategies in favour of inclusiveness. Below, we present the most relevant ones that could draw guidelines for different contexts and purposes.

From the early stages of design, collaboration with accessibility experts, educators, and students with diverse perspectives will be reflected in more holistic products from a sense of inclusivity. Likewise, applying the principles of UDL to generate educational materials and environments to promote access to a plurality of learners will involve greater flexibility in disseminating information, modes of participation, and forms of expression.

In order to ensure that OER complies with web accessibility guidelines, such as WCAG, textual alternatives for images, use of semantic page structures, transcripts, and captions for multimedia content, and allows the navigation and keyboard interaction will need to be provided. Regarding the design of different formats, contents could be provided as text, video, audio,

infographics, and interactive presentations; this will allow students to select the format that best suits their preferences and needs.

Providing translated editions of the OER in various languages would enable disseminating knowledge to a broader and more heterogeneous demographic. Another strategy related to continuous improvement is soliciting feedback from users, especially those with specific needs. The results of this practice will allow you to improve the resources offered continually. To ensure that OER is truly replicable, providing adequate training for educators and designers on creating and using inclusive OER would be useful. Also, open licenses should be guaranteed to allow others to adapt and share OER as long as accessibility is maintained and appropriately attributed.

In a global sense, as a result of the exercise carried out in the workshop, the participants, academics, and researchers recognized the scope of OER from the awareness of their potential to promote inclusion in higher education and research while promoting global collaboration, adaptability, and accessibility. OER can significantly improve the quality and equity of higher education and research.

Conclusions

This study focused on exploring and visualizing good practices in inclusive and accessible education, focusing on three key elements: regulations and guidelines, OER, and platforms that facilitate content delivery. Conducted in a participatory research environment at the Bootcamp "Building the Future of Education Together: Innovation, Interdisciplinary Research, and Open Science" at Comillas, Spain, the study concluded that a multi-pronged approach that includes UDL, D4A, and compliance with the WCAG can significantly contribute to achieving SDG 4 of inclusive and equitable education. The findings, presented as a compilation of good practices, offer valuable insights and resources for the open education community.

The findings hold significant implications for research and practical application, offering a framework for assessing the efficacy of diverse inclusive educational strategies, thereby establishing the foundation for future investigations. The R4C research group at the Institute for the Future of Education intends to leverage these findings to devise innovative educational strategies, thus emphasizing the research impact of the study. Practice-based educators and curriculum developers can use the optimal approaches and suggestions in the review to generate educational environments that embrace a more comprehensive range of individuals. Furthermore, the review emphasizes the importance of synergy between accessibility professionals, educators, and learners in fostering holistic educational tools.

While the study offers valuable insights, it is not without limitations. The participatory research methodology, while inclusive was limited to individuals attending a specific Bootcamp, which may not accurately represent the

wider educational community. Furthermore, the study focused primarily on higher education settings, which leaves a potential for further research in alternative educational contexts, such as primary and secondary schools. Further studies could seek to authenticate the effective strategies identified in this study using empirical approaches and in various educational contexts. Similarly, prospective longitudinal studies are also needed to assess the long-term consequences of implementing these effective strategies on educational outcomes.

Acknowledgement

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5 Transferring Research with Discussions and Conclusions of Value for Knowledge with Social Impact

Mariana Buenestado-Fernández and José-María Romero-Rodríguez

Introduction

Research transfer has become increasingly important in the educational field due to its ability to significantly improve both the quality of teaching and learning outcomes. This process consists of bringing scientific discoveries and advances directly into the classroom, allowing knowledge to not only be continuously updated but also be contextualized in the real problems facing society (Almeida & Sequeira, 2018). Thus, students not only learn theoretical concepts but also become familiar with the practical application of said knowledge (Aznar et al., 2023). This results in a more dynamic, attractive, and, above all, relevant education, as it is aligned with contemporary needs and challenges (Argote & Fahrenkopf, 2016).

The increasing complexity of global issues such as climate change, economic crises, and technological advances requires educational systems to integrate innovative solutions to effectively prepare students (Khan et al., 2022; O'Connell Overton, 2018). This requires a shift in traditional teaching methods, promoting the development of skills such as critical thinking, creativity, problem-solving, and collaboration (Zhou, 2016). Education systems must facilitate environments where students can apply knowledge in practical situations, evaluating and adapting the solutions they develop. Incorporating research allows educational institutions to be more agile and better equipped to adapt their curricula and methodologies to these emerging needs (Wit-de Vries et al., 2019). Thus, institutions that prioritize research transfer not only prepare students for today's job market but also teach them to be flexible, solve complex problems, and adapt to constantly changing environments (Vick & Robertson, 2018).

In this context, the future of education is shaping up to be a more interconnected system, where collaboration between researchers, teachers, and students is key to success. Research will no longer be a process isolated from teaching but will form an integral part of the educational experience (Røvik, 2023). Scientific and technological advances will be seamlessly incorporated into the classroom, fostering the creation of evidence-based

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learning environments oriented towards solving specific problems (Jones & Mahon, 2018). This approach will also promote a culture of continuous learning, where both students and teachers benefit from constant interaction with the latest developments in research.

Education is a fundamental pillar for achieving the Sustainable Development Goals (SDGs) established by the United Nations (2015). It provides the tools and knowledge needed to address challenges such as climate change, gender equality, and poverty eradication. As we move towards a more sustainable future, education must focus on transmitting knowledge and cultivating skills, attitudes, and values that foster sustainability (UNESCO, 2017). This implies a reorientation of curricula to include topics related to sustainable development and fostering students' critical thinking and capacity to act (Vere et al., 2022). Doing so would educate more informed and responsible individuals and lay the groundwork for a more equitable and sustainable future for all (Barth et al., 2016).

Within this background, knowledge transfer and, consequently, innovation emerge as a fundamental pillar. With the progressive evolution of research work and the emergence of discoveries, there is an urgent need to effectively transfer such knowledge to applied and practical areas to optimize its impact and relevance (Vila Merino & Hijano del Río, 2022). The discussions and conclusions inherent in scientific studies are no longer limited exclusively to elucidating findings but extend to delineating how such discoveries can be contextualized, applied, and adopted in different scenarios. This holistic perspective ensures that innovation transcends the theoretical realm, becoming a vital engine for advancement and transformation in multiple fields and academic disciplines.

For all these reasons, the objective of this chapter was to understand the perspective on research transfer of the participants of the Bootcamp "Building the Future of Education Together: Innovation, Interdisciplinary Research, and Open Science. Training of Researchers in Educational Innovation and Sustainability," held in Comillas, Spain, during October 2023.

Transferring Knowledge Generating Social Value

Under the term "social value," principles such as inclusion, equity, equality, support for development, social responsibility, culture, promotion of science, and professional outreach are encompassed (Castaneda & Ramírez, 2021). Based on this, when evaluating the social impact of knowledge transmission, it is essential to consider it thoroughly, aligning the final purpose of university activities with the 2030 Agenda and seeking to achieve the SDGs (De Saá-Pérez & Díaz-Díaz, 2022; Organization for Economic Cooperation and Development, 2019). According to Hung (2018), the indicators subject to assessment within this block are participation in agreements or contracts

with entities and dissemination publications (books, book chapters or articles, exceptionally exhibitions and materials, dissemination activities, dissemination of research in audiovisual media, and professional dissemination).

Transferring knowledge focuses on actions that benefit civil society and its various stakeholders. Elements associated with external visibility and strengthening the university's reputation can be considered. Also included are actions linked to facilitating access to knowledge (both academic and university) for groups in vulnerable situations, as well as collaboration in developing and promoting opportunities in communities with social deprivation (Tõnisson et al., 2021). By positioning themselves as relevant actors in the generation of solutions to social and economic problems, universities and research centres gain prestige and recognition (Chaves Montero & Bermúdez Vázquez, 2022). This not only benefits their public image but can also facilitate future collaborations and strategic alliances with other actors.

Another principal component is access to knowledge. This is not limited only to the dissemination of scientific research in specialized publications, but also involves the democratization of knowledge, ensuring that people or groups in vulnerable situations can access information and resources that allow them to improve their living conditions (Martín Critikián et al., 2021). Universities, through university outreach activities, continuing education programs, and community projects, play an essential role in this process (Taylor et al., 2021).

Knowledge transfer also includes collaborative actions aimed at promoting the development of opportunities in communities with social deficiencies (Santoveña, & Gil Quintana, 2022). This can be manifested through community intervention projects, where academia and society work together to create solutions to improve the quality of life in areas such as education, health, technology, entrepreneurship, and the environment (Sotelino-Losada et al., 2024). The objective is to generate a real and tangible impact on society, while providing feedback to academic research with the experiences and needs of the community.

Knowledge Transfer Models

Knowledge transfer has evolved from simple models to more complex and collaborative dynamics. According to Santos Rego (2022), four transfer models stand out:

a *Research, Development, and Dissemination*. In this model, the university academics are responsible for generating and disseminating knowledge.
b *Problem-Solving*. In this model, users play a significant role in pointing out the needs researchers should address. The researcher is seen as a specialist in charge of responding to user demands. This approach consists of

five stages: recognition of needs, definition of the problem, exploration of solutions, choice of the best alternative, and implementation of the option chosen to meet the need.

c *Link*. Combines aspects of both previous models, ensuring the connection between knowledge producers and users.

d *Social Interaction.* It is based on the co-production of knowledge through interaction between users and researchers.

This last model has gained relevance due to its dynamism and emphasis on the relationship between researchers and users. However, there is criticism that some models simplify the transfer process and do not adequately address education needs. The effective transfer of knowledge is not limited to mere transmission but requires absorption and application (Sjölund et al., 2022). In the academic field of knowledge transfer, conventional models have been criticized for their excessively reductive approach, omitting fundamental considerations in the educational context (Dohn et al., 2020). On the contrary, the social interaction model proposed by Becheikh et al. (2010) moves towards a more holistic and dynamic perspective, highlighting the interconnection between researchers and users and the diversity of means of exchange, from documentary support to advanced electronic devices. Despite the information proliferation characteristic of our contemporary era, disseminating academic findings to their applicators is notoriously slow (Vaz de Almeida et al., 2019). However, it is pertinent to consider that the resonance of a discovery may be conditioned by its immediate relevance and the recipient's ability to connect with sources of information of indisputable rigor and reliability.

Despite the emphasis previously placed on how "practitioners" appropriate research, a need has emerged to adopt a bidirectional perspective that integrates both the production and application of knowledge, exploring collaboration between researcher and practitioner communities. Farley-Ripple et al. (2018) have addressed this prism, highlighting trends that manifest such bi-directionality. Within these trends, they highlight research-practice partnerships, understood as far-reaching alliances aimed at addressing specific educational dilemmas (Farley-Ripple et al., 2017; Penuel et al., 2015). Such partnerships foster a more direct link between theory and praxis, as evidenced in models such as Networked-Improvement Communities (NICs) (Coburn & Penuel, 2016). This collaborative approach allows both researchers and practitioners to co-construct knowledge, driving more tailored and effective solutions to real-world challenges.

The heterogeneity of research approaches in education is supported from an epistemic point of view. However, its importance is magnified if it contributes to outlining strategies that promote knowledge transfer in the educational context. The premise is evident: it becomes essential to foster debate and,

concomitantly, to identify efficient methods for transferring knowledge to the professional educational environment, always considering the interests and objectives of experts in the discipline.

Practical Implementation in the Discussion and Conclusions of Scientific Articles

In scientific literature, the Discussion section assumes relevance regarding the practical implementation of research findings. In this segment, the research is contextualized and placed in the spectrum of tangible applications (Bernal, 2017). While the Results section provides a series of empirical data, the discussion allows researchers to connect these data into constructs of relevance and applicability (Ecarnot et al., 2015). By including a practical approach in the discussion, the authors transcend the mere interpretation of their findings, proposing how these can be capitalized on in specific contexts, guiding decisions and policy formulations, and potentially delineating future research trajectories or sectoral interventions (Cargill & O'Connor, 2021; Penuel et al., 2016). This process makes discussion a key element in translating scientific knowledge into concrete solutions capable of generating a real impact on society.

Similarly, in the Conclusions section, the relevance and significance of the study in the real context is emphasized. This section synthesizes the research and highlights its significance beyond academic boundaries (Jaakkola, 2020). or the reading spectrum, those less versed in the academic sphere, this segment provides a roadmap for how the findings can exert influence or be adopted in their specific work or professional context (Wallace & Wray, 2021). By emphasizing practical implementation in the findings, the authors erect a bridge that connects theory to praxis, thus enabling a smooth transition of knowledge from the experimental or research dimension to the plane of concrete application.

Data Collection Procedure

During the Bootcamp scientific event "Building Together the Future of Education: Innovation, Interdisciplinary Research, and Open Science. Training of Researchers in Educational Innovation and Sustainability," data were collected on three questions related to the transfer of research. For this purpose, the Mentimeter tool was used to collect the responses of the participants who attended in person and virtually the presentation entitled "Transferring research with discussions and conclusions of value for knowledge with social impact." Depending on the question, between 19 and 28 professionals and academics from the educational field participated.

Results

The following is the answer to each of the three questions posed.

Q1. To what degree do you think it is possible to transfer all the research that is done? Of the 28 participants, most (75%) felt it possible to transfer all the research. However, 25% believe the degree to which research can be transferred is low (Figure 5.1).

Q2. To what extent do you think the scientific knowledge we produce is applied for the benefit of society? The participants' responses to this question showed there is little application of the knowledge generated from research for social benefit (73.7%). Only 26.3% considered that it is transferred to society (Figure 5.2).

Q3. Could you share a concrete example of how you have transferred or can transfer your research results to generate significant social impact? Finally, among the most significant examples shared by the participants about the transfer they make are:

> Based on the transfer of the results of the self-evaluation of teaching practice, it is possible to undertake actions towards the transformation and innovation of the teaching and learning process.
>
> Social laboratories to co-create with different communities.
>
> To train disseminators of scientific content in the areas of education, humanities: in the media, social networks, etc.

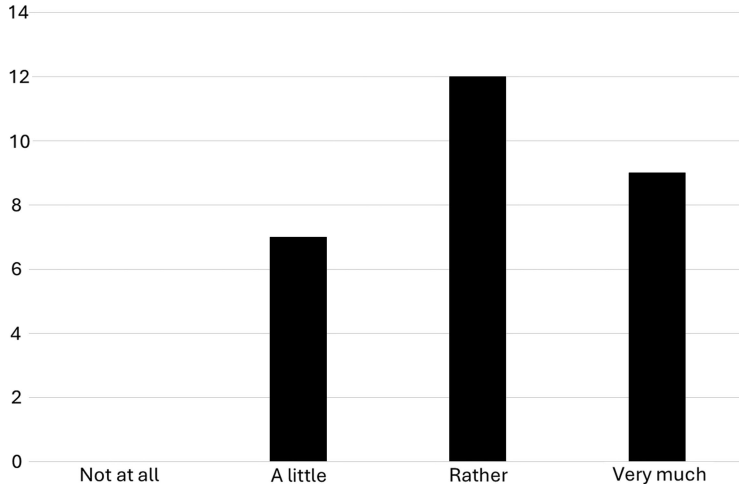

Figure 5.1 Degree to which it is possible to transfer research. Note: n = 28.

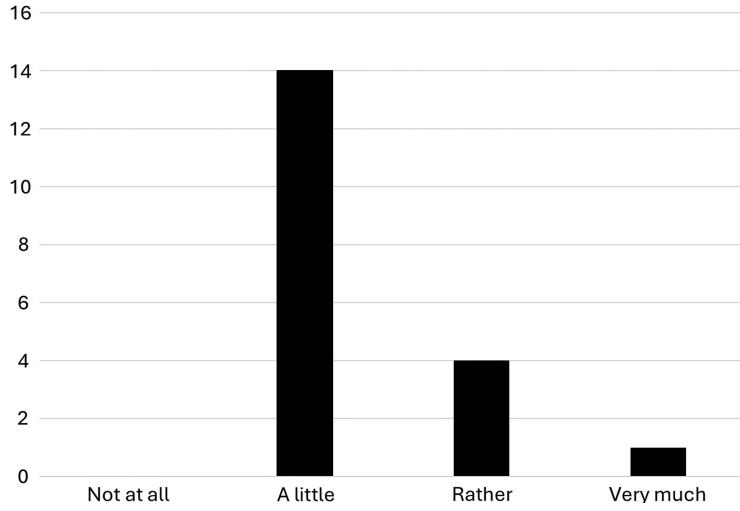

Figure 5.2 Extent to which scientific knowledge is applied to society. Note: n = 19.

Consider the characteristics and needs of the context to which the transfer is to be made.

Use social media platforms and blogs to summarize your findings in an accessible and shareable way. Publish graphics and visualizations that help communicate your results effectively.

Final Considerations

Transfer is a fundamental element in society's development and progress today. Thus, research is crucial to understanding how knowledge flows, how it is transformed into innovation, and how it impacts the economy, society, and welfare in general. In this work, we have responded to this objective by compiling the perspectives of professionals and academics in the field of education who met at a prestigious international academic event.

Knowledge transfer has a practical implication that enriches our theoretical understanding and provides practical insights that companies, academic institutions, governments, and other stakeholders can apply. These insights help to identify obstacles and opportunities in the knowledge transfer process, thus promoting an environment conducive to collaboration, creativity, and competitiveness.

In this line, future research should include a clear transfer route that the researchers intend to carry out with the data and results obtained in the interest of social improvement. The limitations of this experience include the absence

of sociodemographic data on the participants that would allow us to cross-reference variables according to gender, age, or professional experience.

Finally, in an increasingly globalized and knowledge-economy-oriented world, understanding and effectively promoting knowledge transfer is essential to driving technological progress, economic growth, and improved quality of life.

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6 Equity, Diversity, and Inclusion in Open Education

Recommendations to Support Researchers and Practitioners

Carina Bossu and Francisco Iniesto

Introduction

Open Education is a movement aimed at providing widespread access to quality educational resources and opportunities for all, regardless of social, economic, or geographical barriers. It promotes the use of Open Educational Resources (OER), which are materials for teaching, learning, and research that are freely accessible and can be shared, adapted, and reused without restrictions (Wiley et al., 2014). We embrace the definition proposed by dos Santos et al. (2016, p. 5), which states that Open Education is:

> A way of carrying out education, often using digital technologies. It aims to widen access and participation for everyone by removing barriers and making learning accessible, abundant, and customisable for all. It offers multiple ways of teaching and learning, building, and sharing knowledge. It also provides a variety of access routes to formal and non-formal education and connects.

The origins of Open Education can be traced back to efforts to make education more accessible, including the establishment of public libraries and early distance learning programs (Wiley & Hilton, 2009). The movement's overarching aim is not only to expand access to education but also to foster collaboration, encourage innovation, and democratise the dissemination of knowledge via Open Educational Practices (OEP) (Weller, 2020). By removing obstacles, Open Education seeks to promote lifelong learning that is inclusive and adaptable to the diverse needs of learners worldwide (Iniesto et al., 2021).

Equity, Diversity, and Inclusion (EDI) play pivotal roles in shaping an inclusive environment within the context of openness and Open Education (Iniesto & Bossu, 2023):

1 Equity acknowledges and accommodates differences to ensure everyone has a genuine opportunity to succeed.

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2 Diversity acknowledges and values differences among individuals, fostering different perspectives, experiences, and cultures within the educational environment.
3 Inclusion emphasises active participation and belonging for everyone, irrespective of their unique characteristics.

Embracing EDI principles within openness and Open Education supports that OER and OEP cater to the diverse needs of learners from various backgrounds, creating an environment where learners feel welcomed, respected, and empowered to thrive (Bali et al., 2020; Dasli, 2019). This approach enriches the learning experience and aligns with the broader societal goals of creating a fair, diverse, and inclusive educational environment as supported by United Nations Educational, Scientific and Cultural Organisation (UNESCO)'s Sustainable Development Goal 4 (SDG4) (UNESCO, 2020).

This chapter examines three activities conducted in an exploratory research project to understand EDI practices in two different contexts of the Global South, including interviews and workshops in the African and Latin American regions (Bossu et al., 2023). The set of guidelines produced after the analysis of these two studies was presented in an international bootcamp where feedback was gathered from participants. We discuss the summary of the findings and present several recommendations to support researchers and practitioners.

Networks and EDI Support

Open Science encourages collaboration and sharing scientific knowledge across disciplinary boundaries, fostering innovation and addressing complex global challenges (Vicente-Saez & Martinez-Fuentes, 2018). Within that context, Open Research goes beyond traditional academic boundaries, inviting public engagement and democratising access to information (Koçdar et al., 2023). Embracing openness in research practices means making research outputs, data, and methodologies freely available to the public (Cronin, 2017). In that sense, networks in Open Education are vital for fostering EDI values by connecting diverse stakeholders globally, where networks enable collaborative efforts, sharing best practices, and amplifying diverse voices, contributing to equitable and accessible educational environments (Iniesto et al., 2021).

Several examples of supportive networks at a large scale include Open Education Global, which is a worldwide network that promotes Open Education and provides a platform for collaboration among educators, institutions, and organisations; the Commonwealth of Learning, which is an intergovernmental organisation that supports the development and sharing of OER and practices across the Commonwealth; and UNESCO's OER Community, which promotes the development and use of OER, bringing together stakeholders to share ideas and initiatives. More focused initiatives are the Knowledge Equity Network, which is dedicated to establishing a forward-thinking network focused on solutions,

aiming to disseminate research, education, and societal impact globally in a fair manner to enhance adaptability in addressing global challenges, ensuring everyone has equitable opportunities for success (Havemann et al., 2023).

Another example of a focused network is the Global OER Graduate Network (GO-GN), of which the authors are active members. GO-GN constitutes a community of doctoral candidates globally whose research projects centre on Open Education, encompassing OER and OEP. Initiated in 2013, it fosters connections among experts, supervisors, mentors, and interested individuals to form a vibrant community of practice. GO-GN facilitates an annual face-to-face workshop, regular webinars, and online events, creating opportunities for members to present their research and fostering a supportive environment. Complementing these activities, GO-GN produces resources and publications to aid members in their Open Education research (Weller et al., 2023).

EDI has been part of the GO-GN agenda since its foundation, but it was in 2018 that its first project related to EDI was developed. As the network matured, it became apparent that despite all efforts, most participants came from Global North/developed countries. GO-GN currently supports PhD candidates registered at universities in 27 countries; however, only 33 participants conduct research in the Global South (Weller et al., 2022). The concern is that, despite all our efforts to be open and diverse, the Global South is still under-represented and GO-GN is not reaching those who could benefit the most from being part of the network (Rodés & Iniesto, 2021). To bridge this gap and understand the scope of EDI in Open Education around the work in the Global South, the GO-GN team has engaged in two subsequent EDI projects (Bossu et al., 2023).

The first project (2018–2019) focused on EDI practices in Open Education in Africa, which included interviews, a two-day face-to-face workshop in Nairobi (Kenya), and several dissemination events. Findings from this project informed the initial GO-GN recommendations for EDI and provided the foundation for the second project. Project 2 (2020–2021) aimed at investigating EDI in Open Education in Latin America. Considering the impact of the COVID-19 pandemic, 12 online interviews with key Open Education experts across Latin America were conducted, and instead of a face-to-face workshop, the team conducted an online workshop with crucial project participants who had been previously interviewed.

Both projects and the guidelines produced have been shared in international conferences and events such as Open Education Global (2022 and 2023), GO-GN 10th anniversary workshop, Institute for the Future of Education (IFE) Conference 2023, and EDEN 2023 Annual Conference. These led to an invitation to present this research at the two-day bootcamp titled "Building the Future of Education Together: Innovation, Interdisciplinary Research, and Open Science. Training for Researchers in Educational Innovation and Sustainability" hosted in Comillas, Spain, in October 2023 by the Institute for the Future of Education and Innovation Hub Europe (TEC Monterrey). There

was a total of 74 face-to-face and 178 online participants. There, we had the opportunity to gather participant feedback on the guidelines and possible next steps for the EDI project.

Method

Project 1: EDI in Open Education in Africa

This project's aim was exploratory; its findings informed the initial GO-GN recommendations for EDI and provided the foundation for the next phase. Nine interviews were conducted with key Open Education experts and researchers in Africa. The findings from these interviews informed the activities undertaken during the two-day workshop in Nairobi with four invited participants. Data collected during the workshop days were aggregated to existing findings and are summarised below.

The interviews were semi-structured around a series of questions related to the definitions of EDI, barriers and enablers of EDI, and the value and role of communities in supporting EDI. The interview format was flexible to allow for further in-depth discussion as appropriate. The analysis examined responses to the questions included in the interviews and trends across the dataset. Interviews were structured around questions regarding participants' perceptions of EDI; the elements needed to foster an EDI community of practice and research; the type of support that might be needed in the Global South, particularly in Africa, for PhD researchers and early career researchers in Open Education; and the elements of the GO-GN guidelines for EDI.

Project 2: Latin American Context for Open Education and EDI

To continue incorporating perspectives and experiences of under-represented communities, the second GO-GN EDI project was geared towards developing guidelines for EDI in Open Education with relevant stakeholders from Latin America. The EDI Latin American project consisted of online interviews with 12 Latin American experts and an online workshop. This workshop aimed to present and validate data collected and analysed from the online interviews and extract more data that could better inform the GO-GN EDI guidelines for Latin America.

Twelve online interviews were conducted in English. However, two participants were not confident with their ability to speak in English, so we asked them to answer the questions in writing, which were then translated from Portuguese to English. To provide the basis for data comparison, we used similar questions from the African project but adapted them as needed to fit better the population that was interviewed. Data analysis

comprised examining responses to the questions in the interviews and verifying whether there were any patterns or trends across the dataset. Four main coding categories and themes emerged from the data analysis: how EDI impacts Latin America; the need to gain more visibility, opportunities, and challenges; and what is needed to build networks and foster collaboration to reduce barriers.

Bootcamp: Building the Future of Education Together

The objectives of the Bootcamp were to share diverse perspectives and challenges in educational research at the frontier of knowledge, to increase research capacities by incorporating new knowledge and experience, and to create interdisciplinary and open networks to build solutions to address society's holistic challenges and needs. To facilitate participants' engagement during the Bootcamp, participants were asked a set of different questions after each session. Our session was titled "Openness and Networks for Sustainability to Support Researchers and Practitioners" (Martinez-Arboleda et al., 2023). To gather feedback on the EDI projects and guidelines, we asked two questions, which will be presented below.

Results and Discussion

After our presentation at the Bootcamp, we asked participants (face-to-face and online) the following two questions:

- Which region do you think we should focus the EDI in Open Education research on during the next phase?

  Four options were discussed: Asia, Europe, the Middle East, and Oceania (South Pacific). Most participants considered that the next steps of the EDI project should focus on the Middle East and Asian contexts. Also, exploring the different options in Asia, as a vast continent, coincides with internal GO-GN discussions and development for the third EDI project.

- What are the opportunities and challenges of incorporating EDI into your research or teaching?

  Some of the opportunities identified included raising awareness (common understanding) about EDI and improving the quality of learning communities. Predominant challenges were identified as a lack of recognition, funding, and time for both research and teaching.

The findings from both research projects in Africa and Latin America informed the EDI guidelines. These guidelines are a set of guiding principles that prompt questions and raise issues that should be considered by higher education institutions; individuals, including educators, managers, and learners; GO-GN; and other similar open initiatives wishing to create a more equitable, diverse, and inclusive Open Education environment so that it can benefit those who need it the most. Although the EDI guidelines were informed and contextualised by some of the regions of the Global South, they can be changed and adapted to suit different EDI contexts.

Next, we present some elements of the EDI guidelines relevant to the discussions in this chapter; the complete set of guidelines can be found in Bossu et al. (2023).

EDI Guidelines for Higher Education Institutions

1 **Understand and recognise the value of working collaboratively and openly**. Appreciate the significance of collaborative and open work by acknowledging team members' diverse perspectives and contributions. Collaborative efforts between educators, learners, and communities enable the co-creation of learning experiences that reflect diverse perspectives and needs. By adopting open practices, institutions can share resources, ideas, and expertise freely, ensuring that learning opportunities are accessible to all.
2 **Develop strategies to effectively use existing resources, including experts, content, infrastructure, etc., already available to meet institutional needs**. Create efficient approaches for leveraging current resources, such as tapping into the expertise of existing faculty, using available OER, and optimising OEP. By using these resources strategically, institutions can ensure that Open Education promotes equity, reduces barriers, and supports diverse learners in achieving their educational goals.
3 **Develop a diversified measurement of success, in addition to existing metrics.** From an EDI perspective, by adopting existing metrics and measurement of success, higher education institutions continue to reinforce the misrepresentation of academic voices. In addition to existing research metrics, higher education institutions can further enhance their measurement of success by considering EDI factors. By expanding the measurement of success in research beyond traditional metrics to include EDI-focused indicators, higher education institutions can create a more inclusive and equitable research culture.

For Individual Practitioners

4 **Recognise learning barriers that might be intergenerational and part of a historical legacy affecting individuals and communities.** Acknowledge educational obstacles that may span generations and be rooted in

a historical legacy impacting individuals and communities. Recognising intergenerational learning barriers means acknowledging the historical and systemic inequalities that have affected marginalised communities' access to education. By understanding this legacy, individuals can develop strategies that address these deep-rooted challenges, providing targeted support and creating more equitable pathways to learning.

5 **Acknowledge limitations of people's understanding of EDI and their willingness to engage with it.** Recognising the constraints in people's grasp of EDI and their openness to involvement is crucial for open research and collaboration. Acknowledging the limitations of people's understanding of EDI means recognising that not everyone may fully grasp the complexities of EDI, nor be immediately ready or willing to engage with these principles. Individuals may come from backgrounds where EDI concepts are unfamiliar or misunderstood, and others may feel resistant due to ingrained biases or a lack of exposure.

6 **Create a sense of belonging, where learners are valued, leveraged, welcomed, and respected.** A sense of belonging is central to EDI values as it ensures that each learner feels they play a significant role in the learning community. Open Education frequently serves non-traditional learners who may not fit the standard profile. Creating a welcoming environment where they feel their perspectives and contributions are valued is therefore essential.

For Network Initiatives

7 **Understand, identify, and remove structural barriers to collaboration.** In a network setting, comprehending, pinpointing, and eliminating structural barriers to collaboration involves restructuring communication channels, fostering transparency, and establishing inclusive decision-making processes.

8 **Work towards decreasing the language barrier in the network.** In a network, efforts to reduce language barriers involve implementing multilingual communication strategies, providing translation services, and creating inclusive documentation. This approach ensures that participants from diverse linguistic backgrounds can fully engage, contribute, and comprehend information within the network, fostering effective collaboration.

9 **Review the initiative's mission and vision to closely link with EDI concepts.** Networks and Communities of Practice (CoPs) play a crucial role in promoting EDI in their respective spheres. It is essential for these entities to regularly review and realign their mission and vision statements with EDI principles to ensure that they are fostering a culture of equality and belonging for all individuals. By embedding EDI values into their core goals and aspirations, these initiatives can actively contribute to creating

a more inclusive and equitable environment where diverse perspectives are valued and respected. This alignment not only strengthens their commitment to social justice and fairness but also enhances their impact and relevance in today's diverse and interconnected world.

Conclusion

Despite the general association of EDI with educational debates and its implicit presence within discourses and practices related to Open Education, our findings indicated that it is important to consider the specific need to establish connections, acknowledgement, and attentive listening to marginalised voices, as considered by UNESCO's SDG4 (UNESCO, 2020).

GO-GN, as a community of care, understands the responsibility to create an inclusive environment for its members, to champion, promote, and apply equity and diversity principles while fulfilling the network's aims of raising the profile of Open Education research, supporting PhD candidates in the field, and developing openness as a process of research. Findings from these projects have assisted GO-GN in establishing new and validating existing commitments. They have also positively impacted the GO-GN and broader open communities, particularly in the Global South. We acknowledge that there is still work to be done. To uphold our commitment to openness and inclusivity, we intend to investigate further the integration of EDI in Open Education across other regions globally.

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7 Academic Networking for Innovation and Research

Fostering Complex Thinking Through the ORLAB Education Platform

Sandra Martínez-Pérez and Edgar Omar López-Caudana

Introduction

Internationalisation is one of the major and complex concerns of higher education institutions, due to its dynamism and multiple perceptions. Policy trends in recent years have focused on promoting inter-institutional, national, and international relations as a driver for enhancing innovation and knowledge creation. As a result of these relationships, there has recently been an increase in the internationalisation of higher education (teaching, research, governance, management, and associated processes) through new flexible and online learning pathways, recognition, mobility, cooperation, and the development of digital technologies (Tran et al., 2023; UNESCO, 2022). Thus, for Rumbley et al. (2022), internationalisation in higher education is "a multifaceted and evolving phenomenon. It touches on a wide scope of issues and can be defined in a multitude of ways" (p. 19).

To this end, Dagnino et al. (2015), Guan et al. (2015), and Rubach et al. (2017) pointed towards the generation of networks as dynamic sources of development and growth, of social and economic impact. Network building is characterised by a group of people and/or institutions committed to pursuing a common goal through the development of strategic alliances. And they are established through participation and visibility in conferences, congresses, workshops, research stays in other institutions, and social networks, or through the relational fabric, that is to say, the presentation of professional colleagues. Networking, collaboration between different agents, organisations, and countries, provides new opportunities to share, debate, integrate, use resources, offer solutions, and design new scenarios for relations and research.

The process of internationalisation of institutions could be described in six phases: (i) awareness/awareness of the need, purpose, and benefits of internationalisation for the people involved; (ii) commitment of the administrations and agents involved; (iii) planning of objectives, resources, and strategies; (iv) functionality and organisation; (v) quality, impact, and progress of the initiatives; and (vi) recognition and participation of the agents (Ayoubi & Massoud, 2007; Gao, 2019; Knight, 1994). Thus, the process of

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internationalisation contemplates international and intercultural dimensions, and is seen as an essential tool that impacts on the educational, social, cultural, and economic systems of society (UNESCO, 2022).

Several authors like Sarmento et al. (2018), Bulut-Sahin and Brooks (2023), and Mentges and Costa (2023) point out that the internationalisation process should not only be based on an exchange programme or on the organisation of international activities; it should understand the context, identify the objectives and modalities of internationalisation that are to be assumed, and promote a mechanism for improving the training offer and the creation of an institutional policy as a strategy for looking at and positioning oneself in education.

For their part, Dutta and Lanvin (2023), in the *Network Readiness Index*, point out four fundamental pillars for the creation of networks: (i) people (their competences are assessed on the basis of three facets: as individuals, in/with companies, and in/with the public administration); (ii) governance (characterised by the search for a holistic network, guaranteeing the security of its members, whose pillars focus on the creation and accessibility of structures through trust, regulation, and inclusion); (iii) technology (accessibility, content and applications, and future technologies (e.g. artificial intelligence), and (iv) impact focusing on the economy, quality of life, social impact, and contribution to the Sustainable Development Goals (quality of education, gender equality, health and well-being, and environmental awareness).

These work and research networks are characterised by being key elements in internationalisation processes, from a horizontality of their members, and aim for collaboration, participation, communication, creativity, scientific dissemination (articles, chapters, and courses, among others), productivity, and innovation between different agents, research teams, and institutions (García-Valcárcel Muñoz-Repiso et al., 2018; Llopis et al., 2021; Patton & Parker, 2017) that enable the achievement of goals, the construction of scenarios, active listening, and other ways of relating based on equity, trust, respect, mutual support, commitment, and the generation and expansion of knowledge and, consequently, learning.

From this network perspective, and under the premise of collaboration, participation, and generation of knowledge between researchers from different higher education institutions and different countries, the NOVUS project (N21–207) was created *OpenResearchLab: innovación con inteligencia artificial y robótica para escalar niveles de dominio de razonamiento para la complejidad* (coordinated by the Institute for the Future of Education, Tecnológico de Monterrey).

OpenResearchLab: Promoting complex thinking in Higher Education Institutions

Higher education institutions require new paradigms that enable other environments and new responses to the complex learning processes that are so

demanding in terms of the use of disruptive and attractive technologies for students. The *OpenResearchLab* project promotes the exchange of ideas and, through collaborative work between professionals and institutions, promotes the quality of teaching and the development of technologies through the use of didactic resources.

To this end, the aim of the project was to create an open access educational platform, ORLAB, based on artificial intelligence and robotics combining Research-Based Learning and Lifelong Learning, with the purpose of enabling students to develop integrative thinking and to scale research competences, academic literacy, and reasoning for complexity. In this way, it is seen as an enhancer of an innovative, technology-based training model, with components of educational innovation (educational robotics and artificial intelligence), through an interactive space focused on the development of research skills (problem-solving, adaptability, organisation, reflective thinking, ethical-social impact), academic literacy (skills for enquiry, decision-making, proposals and responses to the needs demanded), and reasoning for complexity (Martínez-Pérez et al, 2023; Ramírez-Montoya, 2016; Tecnológico de Monterrey, 2022).

Reasoning for complexity, understood as a meta-competence, requires certain cognitive skills in creative learning contexts that promote scientific, critical, systemic, and innovative thinking to respond to current demands and challenges (Ramírez-Montoya et al., 2022; Tecnológico de Monterrey, 2019). Fostering it in higher education can be considered as a turning point to assume and provide solutions to new sociocultural, economic, and technological challenges, and for the acquisition and development of new competences, with the aim of mapping out personalised and collaborative teaching models and processes for students and contributing to the construction of knowledge (Rodríguez-Abitia et al., 2023; Sanabria et al., 2023). This challenge, when approached through collaboration and academic networking, results in a product shaped by the vision, experience, and contributions of different educational and regional environments, ensuring wider acceptance and assertiveness.

Method

Several institutions, both public and private, were involved in the execution of the project, including the Tecnológico de Monterrey (Mexico), the National Autonomous University of Mexico (UNAM), the University of Seville (Spain), and the University of Cantabria (Spain), making up a total of ten educational institutions, achieving a collaboration of 750 students and the participation of 18 researchers.

The aim was to measure the perception of university students (undergraduate and postgraduate) in relation to their mastery of the competence

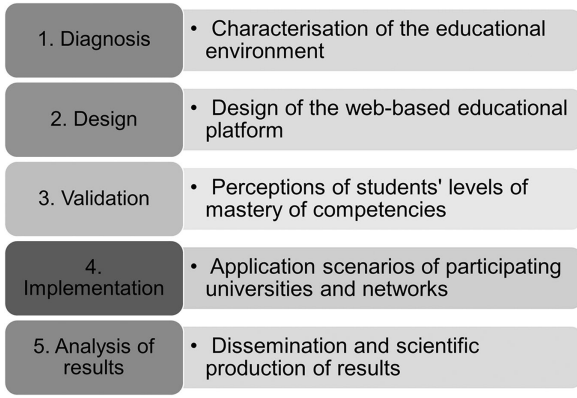

Figure 7.1 Development phases for the ORLAB project.

of thinking for complexity. For this purpose, the research had five phases as shown in Figure 7.1.

The first phase, the diagnosis phase, arose because of the health situation generated by COVID-19. Following the global emergency and the increased use of mobile devices to interact, communicate, work, and continue with the teaching-learning processes, it was considered necessary to analyse the situation in various countries. To this end, contacts were established with teachers/researchers from various higher education institutions with the aim of establishing work networks in search of a dual purpose: to respond to social demands, thinking about learning processes and the search for teaching quality through the use of technologies, and to learn about students' competences in terms of complex reasoning.

As a result of this networking between professionals and institutions, and to respond to the needs detected, a digital educational platform was designed (Figure 7.2). But how to make a platform attractive to participants? The previous question marks an important direction to highlight: the contribution from the experience of the researchers involved, i.e. how to take advantage of an educational platform design from the experience of professionals and teachers in robotics, education and pedagogy and psychology, and the tessituras and demands of university teachers. All this meant a challenge in assertive collaboration. An example of this work is the inclusion and use of humanoid robotics in this platform for carrying out actions and tasks.

Before proceeding to the platform activities, and with the aim of knowing the students' perception regarding the competence of complex thinking, the *eComplexity Instrument: measuring the perception of higher education students regarding their competence in reasoning for complexity*

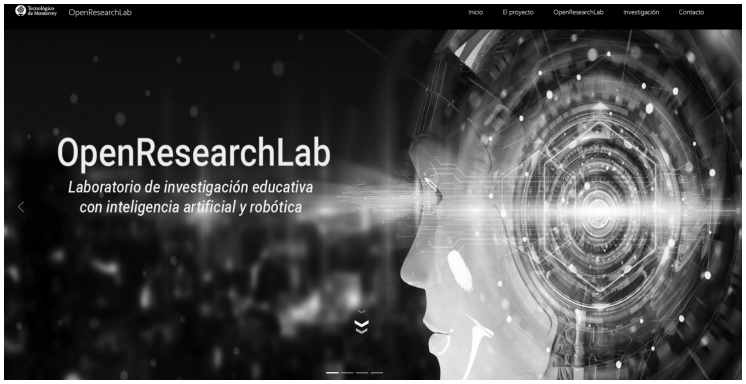

Figure 7.2 ORLAB platform. *Note.* https://openresearchtec.info/

Figure 7.3 ORLAB interaction for scientific and creative thinking. *Note.* https://view.genial.ly/6345d06aafaa2300181a25a2/interactive-content-modulos-orlab

(Castillo-Martínez & Ramírez-Montoya, 2022) was designed and validated. This has two blocks: the first one collects the socio-demographic data of the participating staff, and the second one is composed of 25 items distributed in four dimensions (innovative thinking, critical thinking, scientific thinking, and systemic thinking) with five response options.

In the third phase, in collaboration with the researchers, an activity was designed for the ORLAB platform. As a disruptive technology, humanoid robotics was used, and, through pedagogical techniques such as gamification, personalised learning was sought as shown in Figure 7.3.

This particular activity is made up of five blocks, as shown in Figure 7.3, whose main purpose is to learn what scientific and creative thinking is and, through activities and the support of digital tools, to promote and strengthen the mastery of it, as a sub-competence of complex thinking, the mega-competence at the heart of the *OpenResearchLab* project.

For this, firstly, each participant must answer a questionnaire, consisting of the following sections: description of the survey, informed consent, demographic characteristics of the respondent, personality traits, type of gamified user, type of serious gamer, and motivations for using a technological platform for educational purposes. Upon completion, the user is assigned a profile using a colour. Each module is then accessed. Module I takes the participant to the viewing of a video, individually, whose title is "Research manual for the development of scientific and popularisation articles." The peculiarity of this video lies in the interaction between the teacher and a Nao robot (humanoid, programmable, and autonomous robot from SoftBank Robotics®). Module II, as a continuation of the previous module, consists of a video and requires the completion of an online activity. Module III consists of a synchronous online class again with the teacher supported by humanoid robotics, proving that the application and use of Information and Communication Technologies, Artificial Intelligence and Robotics can contribute to the improvement of classes in higher education.

It is important to note that each activity to be performed is different for each user, which is to say, from each participant's response to the questionnaire, a participant profile is associated with him/her. Bartle (1996) proposed four types of players, and knowing the profile of each participant helps to present personalised learning strategies: achiever, explorer, socialiser, and impulsive. The main goal of the "achievers" is to accumulate points and level up. The "explorers" just look for ways to find new ways to get points. The "socialisers" find out what other players know about acquiring points. And the "impulsive" go for it all, either by eliminating others who get in their way or by earning lots of points. In this sense, each participant has, then, a chosen or planned activity to best accompany them in achieving their goal within the development of the activity on that platform.

And the last phase is the application, again, of the questionnaire to assess whether there was an improvement or "awareness" of the acquisition of the meta-competence of reasoning for complexity through scientific thinking.

Findings

Upon analysing the data, two main axes were observed. With respect to the implementation of the activity on the ORLAB platform, the participants showed that they have a major area of opportunity with respect to the promotion of research skills and scientific-creative thinking, and they are open to ask for and follow general guidelines in this regard. As a relevant result, it is worth

noting that students perceive to have a higher level of mastery regarding some of the sub-competences such as systems thinking in relation to their overall perception of their mastery of reasoning for complexity. The participants felt at ease with the indicated activities following "personalised" learning, and there was a good perception of acceptance towards the indicated tasks and the interaction with the humanoid robot.

And, in relation to the work between professionals and universities, the results of academic networking translate into the publication of seven articles in journals indexed in Scopus, two papers presented at conferences and published in the conference proceedings book, two validated instruments for a postgraduate thesis, and one digital platform. This means that without a common objective and work between the people who work and weave collaborative networks, the efforts of the participants and students, the design and implementation of the ORLAB platform, and the development and validation of the questionnaires, this whole process would not have provided the opportunity to exchange experiences, reflections, knowledge, annotations, and the products previously mentioned.

Conclusions

The conclusions presented here revolve around two main axes. The first is the role of internationalisation as an enriching factor in academic contexts, a promoter of collaborations, the development of values and dialogue, as well as a strategic tool for innovation, social impact and transcendence, and as a means of weaving knowledge and research together. In this way, internationalisation in higher education becomes visible as an intercultural, interdisciplinary, collaborative and supportive approach.

In this sense, the networking and the empowerment of a project made up of various researchers from different academic areas and different higher education institutions. Networks, as a structure (people and organisations), connected by several types of relationships (research, stays and/or exchanges, friendships, or sharing of interests and knowledge, among others), under common objectives, leads to fostering creativity, promoting innovation, learning, generating, and disseminating knowledge. Without all these key elements, the design and implementation of the *OpenResearchLab* project would not have been possible.

And, on the other hand, to highlight that the meta-competence of complex reasoning is having an increasing impact on higher education. The environments generated in universities provide the opportunity to develop innovative, scientific, critical, and systemic thinking, as they contribute from theory, practice, and experience to the acquisition of competences in accordance with current demands, needs, and challenges. Thus, the use of an appropriate interactive platform, such as ORLAB, and with innovative technologies of

Education 4.0, allows the promotion and mastery of such a significant competence for students, such as reasoning for complexity.

To conclude, as has been observed, the introduction of more active methodologies and the use of technologies, such as artificial intelligence and robotics, enhance the acquisition of certain skills and are levers of change for the development of complex thinking. For all these reasons, the inclusion of tools, resources, tasks, and actions that promote such thinking in educational curricula is considered relevant. Thus, for all of the above, the incorporation of collaborative spaces between peers promotes an efficient scenario of academic socialisation, obtaining results for students and those involved in the development stages that make up the *OpenResearchLab*.

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8 Academic Networks and Personal Branding in the Open Education Movement

Carmen Herrero,
Luis M. Romero-Rodríguez
and Francisco José García-Peñalvo

Introduction

The current hypermediated ecosystem has been defined as the "Information Society" or "Network Society", characterised by the importance of social interconnection networks and the infinite capacity of radicular production of information, raising to its maximum power the forms of communication and interaction between individuals (Castells, 2009). The advent of the internet has meant a "mediamorphosis" (Aguaded & Romero-Rodríguez, 2015), that is, the result of the changes occurring within the communication ecosystem due to the convergence of traditional, multimedia and digital media, changes that directly affect consumption habits, transforming the understanding of collaboration, innovation, and technologies to adapt to the citizenship demands. This change has been more significant since the arrival of Web 2.0 (O'Reilly, 2007) and social networks (Facebook, X [formerly Twitter], Instagram, or TikTok) since these are tools characterised by interaction, exchange, and creation of shared content. The ease and ubiquity of access to these interfaces through smartphones and tablets have made them the most widely used platforms by the bulk of the population (see, for example, Comscore reports on the State of Social Media 2022 in Latin America and Elogia's Annual Social Media Study 2022 in Spain).

New opportunities and challenges for science and education are emerging in the current scenario. In the educational field, the term "Technologies for Empowerment and Participation" (TEP) arises to refer to the use of technologies in social environments to give rise to the creation of collective knowledge (Latorre-Iglesias et al., 2018). Today's society offers multiple options for accessing learning. One of them is generated from the collaboration and interaction of members of virtual learning communities (Gómez-Martínez & Romero-Rodríguez, 2021), which means that social networks can be understood as an informal learning environment (Jenkins et al., 2009; Scolari, 2018) of considerable scope and increasing popularity. Likewise, the emergence of social networks and the development of new technologies that facilitate

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the creation of virtual communities have encouraged a growing number of academics to participate in these spaces for the production, exchange, and dissemination of resources and information (e.g., Academia and, especially, ResearchGate at present), practices that, at the same time, contribute to the formation of a personal brand and a digital identity as academics (García-Peñalvo, 2018a).

This chapter identifies the distinct functions of this type of network in the educational field. It also examines how the participation of academics in communities of practice and (virtual) affinity spaces contributes to the professional development of educators and researchers. It also analyses how this networking constitutes an essential component within academic and scientific professional practices when creating a personal brand. This study shows how participation in open communities of practice can help amplify the reach and impact of open educational resources and scientific publications through transmedia communication strategies. Being part of these networks that drive the open educational movement enriches the personal brand and contributes to the sustainability of academic projects by appealing to and involving different sectors of society.

Key Concepts

Mobile device users can install multiple applications to create, share, and access information without space-time barriers. Social networks, understood as communication platforms that aim to connect people more easily and quickly, have generated a high degree of interconnectivity among citizens, as they allow them to exchange all kinds of files (audio, text, video, etc.) as well as share hobbies and interests with dozens and dozens, hundreds, and thousands of people at the same time. There is no concrete distinction between producers (senders) and consumers (receivers) on these platforms; in other words, everyone is considered a participant with different degrees of influence depending on their presence on the net. Hence, in this new media paradigm, "prosumption" is emerging as a trend (Ritzer et al., 2012), where "prosumers" tend to be proactive users who share content and ideas that contrast with other participants to originate distinct types of learning and serve as a help to the community.

The active participation of users is part of a process of cultural transformation called "participatory culture" (Jenkins, 2008, p. 15), which takes place within the framework of "media convergence" that "encourages consumers to search for new information and establish connections between dispersed media content". The prominence of images and screens in the current era is part of a new communications ecosystem to which information and communication technologies (ICT) have contributed. At present, participatory culture facilitates and promotes the creation and distribution of multimodal digital

artefacts in different formats. Media convergence has driven the expansive process of "transmedia storytelling", which facilitates the media flow of stories and resources through different communication platforms (Jenkins et al., 2009).

This collective creation process is based on "collective intelligence", a notion formulated by Lévy (1997), who argues that cyberspace makes sharing resources and skills easier and helps democratise knowledge since everyone can be a mediator. At this point, it is appropriate to link these online collaborative networks with Wenger's (1998) concept of "communities of practice" and Gee's (2005) "affinity spaces". The former refers to the experiential learning processes that occur among groups of people who share an interest and a desire to solve a problem, or deepen their knowledge in a specific area and carry it out by interacting regularly. Communities of practice are still present in society, albeit in a virtual format (Herrero, 2016). The second alludes to spaces where people organise themselves because they have a similar affinity to acquire various forms of knowledge, share content, and create resources. In these spaces, which can take place in the real world or virtually, the idea of belonging to a community does not prevail, and the hierarchical roles of leader and follower are porous and interchangeable.

Academic and Scientific Networks

Web 2.0 and the widespread use of social networks have affected various areas and habits of daily life. Inevitably, this has impacted how content is learned and entrenched through processes in which users assume an active role in collaborative learning (Calle-Álvarez & Ocampo-Zapata, 2019). However, informal learning strategies and developing competencies during non-formal learning autonomously or through digital tools and resources remain undervalued and actively exploited in the educational environment (Scolari, 2018).

In principle, two types of learning communities can be differentiated in virtual spaces: those that are formally organised, such as different platforms linked to institutions that serve as supports for virtual courses like MOOCs (Massive Online Open Courses) (García-Peñalvo et al., 2018) or online education (Zawacki-Richter & Anderson, 2014), and those that arise spontaneously in an informal way (Lantz-Andersson et al., 2018) in spaces such as social networks, blogs, or forums. Thus, according to Piscitelli et al. (2010), social networks influence education through the collective intelligence formed by groups of prosumers. Hence, the concept of Personal Learning Environment (PLE) acquires particular importance, which Adell and Castañeda (2010) define as "the set of tools, information sources, connections and activities that each person uses assiduously to learn". A PLE comprises three types of tools and strategies: those for reading, those for reflection, and those for relationships. ICT and the applications offered by Web 2.0 increase the potential and

number of tools and expand the opportunities to enrich individual and collective learning.

It should be noted that these learning networks are not only carried out by students since teachers and researchers also participate in various virtual spaces of affinity that contribute to their professional development. The principles of this learning ecology are also transferred to the so-called Professional Learning Networks (PLNs) or Personal Learning Networks. These dynamic ecosystems of people, spaces, and tools respond to educators' professional development needs, interests, and goals (Trust et al., 2016). This form of informal learning allows educators to build knowledge with peers to develop teaching practices collaboratively (Trust et al., 2016). Teachers and researchers use social networks such as X, Facebook, and Instagram (Carpenter et al., 2019; Visser et al., 2014) to collaborate with peers in different academic centres or institutions. These virtual communities of practice of like-minded teachers provide new modes of professional development through the development of collective learning and the building of personal relationships, including the emotional support evident during the pandemic caused by COVID-19 (Herrero & Spence, 2023; Kalmar et al., 2022).

It is in this context where the so-called educational influencers appear, which are users who, given the content they share, obtain an organic growth of their accounts, not only in the number of followers but also in interactions, such as likes, comments, and shares-, which organically increases the engagement and reach of the accounts. Many of them opt for informal leadership, and a trend has been observed among influencer-type practices for sharing open educational resources (Carpenter et al., 2022). As Marcelo and Marcelo (2021, p. 81) point out, many of these influencers "act as 'knowledge brokers' (Plair, 2008), or necessary intermediaries who select, create, share, value resources or information". Also emerging are the so-called "teacherpreneurs", educators involved in the teaching-learning process proactively who share their resources, materials, and ideas, through different for-profit web platforms (Shelton & Archambault, 2019).

Associated mainly with the corporate model, another concept on the rise in academia is the concept of personal or professional branding and the various terms used to create it (professional branding, personal branding, human branding, personal marketing, self-branding, and self-marketing) (Jacobson, 2020, p. 715). Personal branding can be defined as the process and strategies a person undertakes to create, develop, and maintain an identity associated with his or her professional work and the practices he or she employs to communicate his or her profile in both virtual and natural spaces. In their research, Gorbatov et al. (2018) propose the following definition: "Personal branding is a strategic process of creating, positioning, and maintaining a positive impression of oneself, based on a unique combination of individual characteristics, which signal a certain promise to the target audience through a differentiated

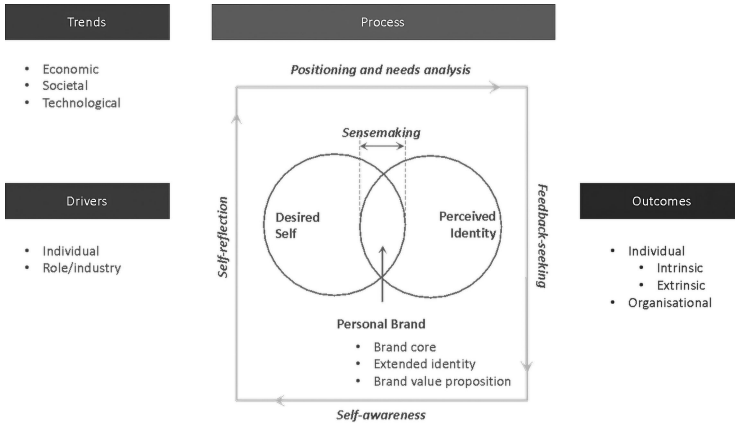

Figure 8.1 Personal branding model (Gorbatov et al., 2018).

narrative and imagery" (see Figure 8.1 for the conceptual framework proposed by Gorbatov et al. (2018)).

It is often an activity linked to producing and disseminating scientific work. As Medina Calvo (2021, p. 77) points out, it is based on principles such as "self-improvement" and academic "self-promotion" to improve the professional and research profile linked to the quality, scope, impact, and prestige of their publications in scientific journals. This form of academic entrepreneurship translates into active participation in the most used social networks (Facebook, Istagram, YouTube, or X), those with a more professional character (such as LinkedIn) or academic networks that give visibility to scientific publications (e.g., Academia, ResearchGate, and Kudos), which allow the establishment of different forms of communication, exchange, and collaboration, and contribute to increasing the dissemination of their work. These networks are digital spaces that are particularly important for postdoctoral academics and professors in their first years of teaching, as they serve as emotional support and contribute to developing their identity and professional digital profile, especially in times of uncertainty and instability.

This process of building a personal brand requires both digital and communication skills, along with other skills (negotiating skills, flexibility, creativity, leadership, positivity, persistence, problem-solving, and effective time management) (Shyle, 2022, p. 213) to develop an appropriate strategy to reach both academic networks and a broader audience in the future (Jacobson, 2020). In this process, it becomes essential to be a "curator" in social networks, a task that involves archiving digital artefacts and cultural practices and being a "storyteller" of one's brand (Jacobson, 2020, pp. 720–721).

In this area, participation in open educational networks (Antón Ares, 2018; García-Peñalvo, 2018b) can be a high-impact strategy, something that has not been considered in the few scientific investigations dedicated to studying the professional branding of academics and scientists. While it is true that the concept of personal or professional branding emphasises the fact that it is an individual process, the "curation" of open educational resources and open-access scientific publications can contribute to generating a more significant impact and, therefore, increase the current and future audience (García-Peñalvo, 2021). It also generates a positive impression of the individual's professional profile and increases public recognition, and the professional value of the practices performed (see Figures 8.2 and 8.3). Above all, it makes these spaces and practices of open and inclusive education and research visible by contributing to several types of collegial interaction to mobilise knowledge-based responses with social impact and create a more

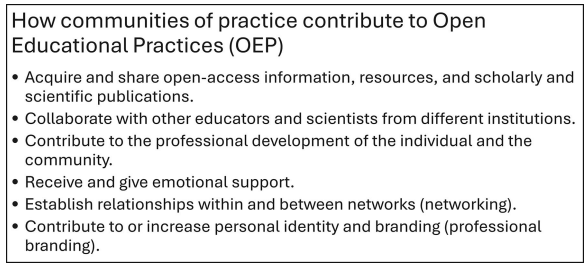

Figure 8.2 Communities of practice in the professional field and open educational practices.

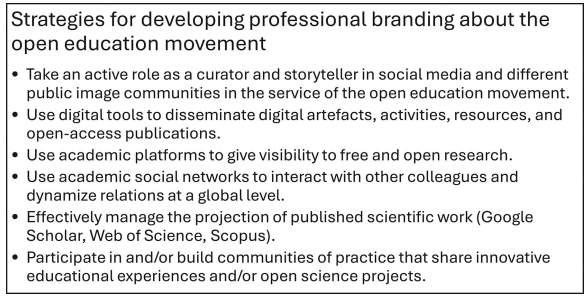

Figure 8.3 Strategies for developing professional branding concerning the open education movement.

inclusive society (García-Holgado et al., 2020; Nascimbeni et al., 2018; Nascimbeni & Burgos, 2019).

Conclusions

The evolution of learning and continuing professional development contexts requires educators and scientists to adapt to new circumstances and know how to use digital tools. Given the reach of social networks in social and academic life, it is difficult to avoid using these communities as part of professional learning and the relationships established in different real and virtual environments.

In the face of a mercantile model, this chapter argues for the value of linking professional branding to the practices of creating and disseminating open educational publications and resources. One of the recommendations that emerges from the assessment of this strategy is the need to train new teachers, educators, and scientists in creating and developing the professional brand and their digital identity as academics within the framework of the objectives and needs of the open educational movement.

Finally, creating professional branding in the academic-scientific field is one aspect that needs more empirical research. Several lines of work should be addressed, such as the intersection of communities of practice, professional branding, and its contribution to the open educational movement in various universities and educational settings nationally and internationally.

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