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Editorial: Open education for sustainable development: Contributions from emerging technologies and educational innovation

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Editorial on the Research Topic

[Open education for sustainable development: Contributions from emerging technologies and educational innovation](#)

1. Introduction

The difficulties in carrying out formal educational processes are not a novelty; historically, some examples, such as the cuneiform pictograms dating back to 3000 B.C., speak of the problems that the Sumerian people had in educating, disseminating the knowledge to reach future generations, and finding ways to translate the representations into productive processes. It has been 5000 years since those Mesopotamian schools tried to establish a systematization of knowledge through educational institutions. From this perspective, we must understand that educational institutions must constantly be moving, pending social dynamics, adapting, and in many cases, anticipating the transformations that human beings undergo in their daily lives. We must understand excellence as Galeano commented, "Utopia is on the horizon. I walk two steps, it moves two steps away, and the horizon moves ten more steps away. So, what is a utopia for? That's what it's for, to walk.

When we think of trying to find solutions in education, the starting point is the observer's perspective in evaluating the process because it is vital to visualize the whole panorama. We must have a macro view, but without neglecting the micro instances that make up the whole social phenomenon; that is, the tree does not prevent us from seeing the forest, and the forest does not prevent us from examining the particularities of each tree. Bibliometric analyses of complexity identify challenges for education (Baena-Rojas et al., 2022; Ramírez-Montoya et al., 2022a; Suárez-Brito et al., 2022; Vázquez-Parra et al., 2022), where the habits of mind of systems thinking are fostered, with educational interventions that build and enhance the complex system

with constituent subsystems (Kastens and Manduca, 2017). In particular, Morin (2019, 2020) invites us to think of complexity as “interwoven,” where the parts are analyzed in the whole and the whole in correspondence with its parts. How are the parts linked in educational processes?

These words, close to a metaphor, do no more than try to show that to analyze educational phenomena, it is necessary to consider the political, economic, and cultural characteristics peculiar to each student in the scenarios where the act of teaching takes place. The pandemic that devastated the world in 2020 showed us the uncertainty of the future and left some lessons to be learned, ranging from the rational use of technologies to the economic and social differences in various sectors of the population around the world that impacts education. Ramírez-Montoya et al. (2022b) speak of the future of education as imprinted by open education that interweaves purposes, challenges, and complex scenarios. Similarly, Sanabria-Zepeda et al. (2022) put into perspective the importance of promoting open science to respond to the challenges of the Sustainable Development Goals. Global and local requirements spotlight the need for educational institutions to provide answers.

One of the most significant aspects of the transformation generated by the COVID-19 pandemic was its direct effect on using technologies to overcome distance barriers. Stracke et al. (2022) exposed COVID contextual actions with open education practices. Likewise, Vicario et al. (2021) presented a diagnosis of Mexican institutions facing the crisis; also, García-González et al. (2022) analyzed how Spanish institutions faced the crisis. In many cases, these technology implementations were carried out exclusively for communicative interactions between teachers and students, not designed for an educational project with a precise foundation. Thus, it is now imperative, understanding the importance of using technology, to design and establish concrete strategies in the assessment, use, and implementation of specific tools, according to the context of the intended practice. The educational institution should not evaluate itself, excluding its community. A better knowledge of the population that is part of the educational community leads to more effective problem solutions.

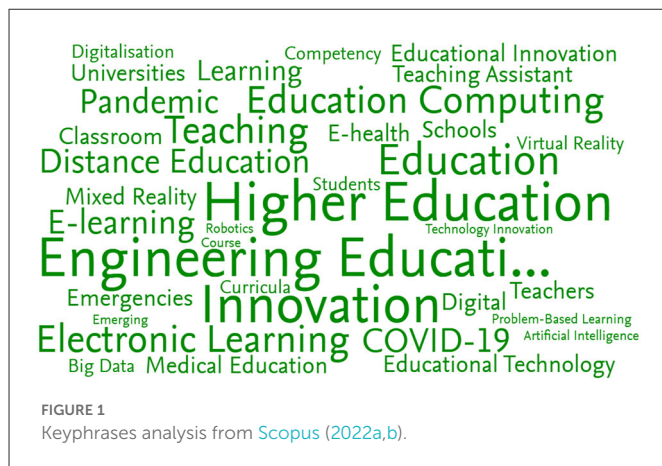
When we think of “the context,” we must bear in mind that societal characteristics at the beginning of the 21st century present us with a panorama of the future that is difficult to predict. The new forms of interactions between people, the characteristics of consumption, new jobs, the massification of technological supports, and almost unlimited access to information have created new types of relationships. They have built parallel imaginaries between the tangible and the intangible, spaces in which it is difficult to differentiate what is real from what is not. Considering the context of these characteristics, educational institutions must undergo a fundamental transformation that provides new generations with learning spaces and transmit a culture that allows understanding our condition and favors open and free thinking. In this sense, this paper presents articles from a call for papers that aimed to share open education practices and educational innovation from socio-cultural, political, psychological, historical, economic, legal, and political perspectives, where emerging technologies and educational innovation have played a vital role in sustainable development.

1.1. Open education for sustainable development

Sustainability and education share an intertwined and complex path. On the one hand, sustainability depends to a large extent on quality education, as stated in the UNESCO Sustainable Development Goals (UNESCO, 2014). On the other hand, education has to be sustainable. Thus, there seems to be a cycle of interdependence that can be virtuous or vicious, depending on the context. Some authors state that there are greater sustainability challenges according to geography, because they consider that, in the so-called Global South, the minimum conditions for quality education are often non-existent. These authors also indicate that open education seems to have great potential for development in these contexts, offering the possibility of leveling the scope of training in comparison to developed economies. Kanwar et al. (2010) focus on the potential of open educational resources (OER) to provide access to quality content and guidelines for sustainable OER. Yuan and Powell (2013) are concerned with the sustainability of massive open online courses (MOOCs) and their relationship with OER. They focus primarily on the funding model and the intrinsic value of providing non-credit, no-cost materials. This sustainability is particularly important given the great potential of these educational tools under budget-constrained conditions. McGreal (2017) reinforces this notion of the potential of OER and MOOCs to achieve UNESCO’s Sustainable Development Goal 4 (SDG4), particularly for developing countries, but recognizes that they are also useful for underserved communities in the Global North.

There are some common characteristics identified in the literature for open education to be effective and sustainable. Two of the most commonly named are reflection and transformation. The use of inquiry-based learning (Pretorius et al., 2016) adds value to learning experiences and supports transformative learning. Bell (2016) adds that most discussions of twenty-first century education focus on service, rather than focusing on transforming the global economy. Bell amplifies his idea and asserts that connecting education to sustainability can result in a shift from conventional to transformative educational styles. However, Wamsler (2020) does not seem to agree that the focus has not been on the global economy. Instead, she argues that sustainability science and education have focused on ecosystems, broader economic structures, technology, and governance, an approach that hinders the impact of sustainability education, as there is limited capacity to produce reflection due to the neglect of internal dimensions or capacities. However, she agrees that educational transformation is needed in order to be successfully sustainable.

Finally, the role of teaching has a definite effect on the relationship between sustainability and open education. This is even more critical when it comes to open education, where teacher involvement may be considered hidden, but never absent. Moreover, engagement with sustainability issues may be less than desired, despite having adequate policies in place, both at institutional and national levels (Tamrat, 2021). Laurillard (2008) states that teachers need to adopt an open teaching approach by becoming technology experts, sharing knowledge and materials, innovating pedagogical strategies, and taking advantage of digital technologies. This is how sustainable open education can be achieved. However, it is important that teachers share a common understanding of what open education



means. Shephard and Furnari (2013) observed that teachers have four different interpretations of education for sustainability, but only one is positive toward its development.

In summary, open education has enormous potential to promote sustainability, but it also has to be sustainable in itself. The effectiveness of any effort to educate for sustainability with open education tools will depend on adherence to a model that seeks to promote reflection and transformation. In addition, the role of the many stakeholders in the process, such as teachers, students, and policymakers, can greatly promote or inhibit its performance.

1.2. Emergent technologies for educational innovation in complex environments

The solution to scenarios with complex problems requires multidisciplinary collaboration, and it is necessary to emphasize aspects such as good decisions and effective communication. The presence of vanguard Information and Communication Technologies in current work environments requires a revolution of the current educational model. Therefore, today's universities must develop strategies for students to improve many skills and generate the necessary competencies to resolve the complex problems in these scenarios (Cortés et al., 2022). It is crucial to use emerging technologies in university education, with open innovation characteristics and educational strategies, to promote innovative and collaborative active learning techniques to develop skills to meet societal challenges within the context of Education 4.0. In Kanstens (2012), an example of using an appropriate technological program called InTeGrate is exposed where an educational intervention is generated for students to visualize themselves as builders and designers of a complex system with modular subsystems in the area of geosciences. This complex scenario first comprises an essential set of subsystems, then how they interact and generate parallel semi-autonomous subsystems replicating and adapting as experience accumulates. In this way, complex thinking capabilities are developed through their systemic, innovative, creative, and scientific components.

From Scopus, we can observe the key phrases to know what topics are most prominent about combining emergent technologies, educational innovation, and complex scenarios (Figure 1).

Besides broadening their disciplinary perspectives, optimizing their strategies to approach the objects of knowledge, and increasing their interrelations with various organizations (educational, business, political, and social), educational institutions must not fail to direct their objectives toward the welfare of the population. To achieve this, open education is a valid option.

Society requires new options for its welfare, where education, especially open education, offers new opportunities for sustainable development. In 2015, UNESCO identified sustainable development goals for social well-being and, in 2019, defined new recommendations for open education, calling on member states to promote actions for building open and inclusive knowledge societies and achieving the UN Sustainable Development Goals. It is vital to attract practices and research that can bring practical and scientific knowledge in support of the cutting edge of society, with social media studies underpinning open education and its implications for the sustainable development of society. In the face of dynamic changes, crises, and challenges, opportunities arise for education, science, media, and technology. Open education converges in design and practical applications with visionary, operational, and legal openness to improve opportunities for all people and contribute to the sustainable development of society.

These analyses generated the idea of creating this research monograph to continue building inter-institutional relationships to learn and share and disseminate practices of open education and educational innovation from socio-cultural, political, psychological, historical, economic, legal, and political perspectives, where emerging technologies and educational innovation play significant roles for sustainable development and the welfare of the population.

2. Presentation of the monographic articles

Of the total number of articles received for this Research Topic, 10 papers, consisting of two reviews and eight original investigations, were accepted. We organized the accepted contributions according to the areas of practice and research covered.

Five papers are concerned with how the COVID-19 pandemic forced teachers to implement digital tools and materials to continue their students' education. Ponce et al. proposed an undergraduate course called "Digital Control of Electric Machines" (electric drives) which implemented the Tec-21 Educational Model of Tecnológico de Monterrey, V Model, MATLAB/Simulink, low-cost hardware, and complex thinking. This course used simulations as a virtual strategy, allowing students to acquire hard and soft skills in their education. Martínez-Pérez et al. analyzed the educational possibilities of T-MOOCs for the development of digital competencies in teachers as a strategy for open education and the development of sustainable goals. The results of this study, conducted using 313 students of the Primary Education Degree at the University of Seville (Spain), revealed that training in educational technology is needed to acquire digital competencies. Pasquel-López et al. described how the COVID-19 pandemic urged educational institutions to use resources contained in public repositories, such as YouTube, turning teachers into "EduTubers." Thus, the study used social network analysis to explore the dynamics of EduTubers to understand the motivations for their interactions. Ruiz Loza et al. described how, during the pandemic, it was possible to develop mathematical

TABLE 1 Papers accepted for this Research Topic.

The 10 papers accepted in this Research Topic	Technologies and educational innovation	Open education for sustainable development	Complex environment, robotics, and educational innovation	COVID-19
Type: Original article				
1. Ponce et al.	X		X	X
2. Cox et al.		X		
3. Otto and Kerres		X	X	
4. Santos-Hermosa and Atenas		X		
5. Martínez-Pérez et al.	X	X		X
6. Class		X		
7. Pasquel-López et al.	X			X
8. Ruiz-Loza et al.	X	X	X	X
Type: Review				
9. Chaka		X		
10. Montiel and Gómez	X			X

competencies in undergraduate students through virtual learning environments. They used 3D visualization tools and a project-based strategy and measured the spatial skill of more than 200 students. They proved that virtual environments are useful for developing skills through active learning. Finally, the review conducted by Montiel and Gomez-Zermeño about teachers' competencies in ICT identified 23 studies related to using ICT tools during the COVID-19 pandemic. The results suggest a rise in using ICT tools in learning environments, encouraging organizations to implement UNESCO's "Information and Communications Technology Competency Framework for Teachers."

The other five papers are focused on the topic of sustainable open education. Cox et al. presented a model of open textbooks to address social justice in the classroom and to promote inclusion. The study applied Bovill's framework of inclusion in the analysis of the degrees of inclusiveness of 11 open textbook initiatives, focusing on student participation. Otto and Kerres argued that it is necessary to increase the discoverability of available OERs in different locations and platforms, adding intelligence and promoting interconnectivity. They used the learning ecosystem approach to illustrate their proposal. Santos-Hermosa and Atenas conducted an exploratory study about how openness to knowledge is being taught in Library and Information Science schools (LIS). They concluded that LIS schools are not providing formal training to gain skills and competencies in openness, and this instruction is now given by librarians. Furthermore, Class conducted a reflective report with thoughts and praxis on Open Education and Open Science as a public good. The author provided some theoretical framework with conceptual tools and suggestions for researchers on openness. Finally, Chaka reviewed published journal articles on Education 4.0 in higher education aimed to promote and develop sustainable development goals (SDGs). The author found that real-world Education 4.0 is confined to certain countries and certain higher-education institutions. Moreover, related technologies are classified as disruptive, scalable, and sustainable, and the soft skills cited are not exclusive to Education 4.0.

Table 1 presents the 10 accepted papers organized by the three Research Topics of the call, as well as the articles related to COVID-19:

The compilation of papers for this Research Topic aims to inspire and promote the research around sustainable open education, improving knowledge of technologies, and educational innovation strategies in this post pandemic time.

3. Conclusion and new avenues

The objective of this work was based on the understanding of the need for a shared effort to bring together as many voices and perspectives as possible to help design the paths toward the most democratic educational forms possible, with a scope never seen before, by taking advantage of the possibilities offered by new technologies and supported by the tools provided by open education.

We do not expect unique solutions, but rather that the result of the interactions of each of the contributions will allow us to take elements adjusted to the realities of each context and put them into practice in specific scenarios. Furthermore, these new ideas will be useful to establish lines of research that can show the impact of new practices. Such documentation will allow for evaluation that can serve to make precise decisions in the search for results that will benefit communities.

It is difficult to speak of the future of education when the problems of society must be solved in the present with posterity in mind. Thus, future studies must take into account that the complexities and dynamics of society mediated by information and communication technologies require short-, medium-, and long-term answers. The threats to humanity are not only epidemics, but also include the degradation of the biosphere that threatens the disappearance of species, social inequalities, and the proliferation of weapons and wars: in short, dangers to the survival of the human species. Education must become the axis that helps the development of a spirit of solidarity and responsibility centered on

planetary awareness. This is a humanistic perspective with the hope of achieving a better world for all.

Author contributions

MR-M and DH-M: conceptualization. MR-M: methodology, writing—review and editing, supervision, and funding acquisition. MR-M, GR-A, DH-M, EL-C, and CG-G: investigation. GR-A, EL-C, and CG-G: writing—original draft preparation. DH-M: visualization. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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