Introduction   doi.org/10.7213/1981-416X.23.077.AP02

Emancipatory Open Practices for Sustainability with Science and Emerging Technologies

Alexandra Okada [a] iD
Milton Keynes, United Kingdom
The Open University UK

Miriam Struchiner [b] iD
Rio de Janeiro, RJ, Brasil
Universidade Federal do Rio de Janeiro (UFRJ)

Maria Elizabeth Almeida [c] iD
São Paulo, SP, Brasil
Pontifícia Universidade Católica de São Paulo (PUC-SP)

Thais Castro [d] iD
Manaus, AM, Brasil
Universidade Federal do Amazonas (UFAM)

Alboni Marisa Dudeque Pianovski Vieira [e] iD
Curitiba, PR, Brasil
Pontifícia Universidade Católica do Paraná (PUCPR)

[a] Doutora em Educação, e-mail alexandra.okada@gmail.com
[b] Doutora em Educação, e-mail miriamstru@gmail.com
[c] Doutora em Educação, e-mail bbethalmeida@gmail.com
[d] Doutora em Informática, e-mail thais@icomp.ufam.edu.br
[e] Doutora em Educação, e-mail alboni@alboni.com

Introduction

The 2030 Agenda, which consists of the 17 Sustainable Development Goals, is a United Nations-established program committed to solving global challenges and promoting peace and prosperity in the contemporary adverse world (UNESCO, 2021). Emancipatory education plays a central role in empowering both the current and future generations for the praxis towards the collaborative construction of a desirable future for all. Achieving life sustainability in the present world is one of the greatest challenges that education faces.

> The term "sustainability" requires a deep understanding of its essence to avoid indiscriminate or superficial use. Sustainability is not simply the same as the term "sustained," which means maintained at length without interruption or weakening. Rather, sustainability is a much wider and more profound concept that encompasses the careful, ethical, wise, and responsible ability of life coexistence on Earth through times, both individually and collectively, at local and global levels, and across environmental, economic, and social domains. Achieving sustainability requires emancipatory education based on the Freirian praxis to become a concrete reality. This involves partnering among educators, learners, specialists, citizens, and policymakers in constant dialogue to problematize together and discuss important questions (with care). It requires understanding socio-scientific and cultural realities through knowledge (know) and taking actions (do) as ethical historical political beings who reason critically and transform the world for the better through collective awareness derived from scientific-humanized action and reflection (OKADA, 2020; p. 12).

To address the challenge of education for sustainability, the CARE-KNOW-DO principles (OKADA, 2020) were established to enhance emancipatory practices. Its aims is to enable students with teachers, researchers, citizens, and managers, to identify real-life problems that they CARE about, need to KNOW, and DO actions for solutions. These principles are based on autonomy and humanization (FREIRE, 1967/1984/1996/2009) and science for responsible citizenship (HAZELKORN, 2015; RATCLIFFE, 2003; HODSON, 2011). As lifelong co-learners and co-researchers, we need to connect with science and technology for knowledge acquisition and decision-making in real-life contexts. Emancipatory practices that enable learners to develop human, digital, and scientific skills are essential for solving problems in an innovative, enjoyable, and responsible way for sustainability.

With that intentionality, the emancipatory education for independent thinking (OKADA; SHEEHY, 2020) makes it possible for the less well-represented students to develop critical thinking of their contexts and the world for the transformation, with fun, in the process of seeking and discovering (FREIRE, 1967/1984). Learning in an emancipatory and fun way allows students to be in the leading role of their history with their intrinsic motivation and genuine pleasure through cooperating with their peers. Many papers presented in this dossier highlight learning supported by the pedagogy of autonomy, making it possible for the learners to become enthusiastic, proactive and energic transforming agents to innovate their reality and to build a better world (FREIRE, 1996/2009).

It is essential to promote sustainability and emancipation for all. This dossier presents practices based on various open approaches, ranging from well-known ones such as open education, open learning, open educational resources, and open learning platforms, applications, and objects, to the most recent concept of open schooling. While sustainability is not the same as sustained, and open schooling is not synonymous with open education, they can both coexist in an integrated way. The term "open schooling" was introduced in a report by the European Union called "Science Education for Responsible Citizenship" (HAZELKORN et al., 2015), where it was not linked to open education. However, Okada and Sherborne (2018) and Okada and Rodrigues (2018) later associated it with open education and introduced it in Brazil as "escolarização aberta" in Portuguese. Based on theoretical and practical studies, open schooling has been developed in various large Europe-Brazil consortium projects such as ENGAGE, weSPOT, and CONNECT, all of which are funded by the European Union from 2015 to 2025. Open schooling involves

learners, teachers, and researchers working collaboratively to address real-world problems through interdisciplinary and inquiry-based approaches.

According to the European Commission (2018),

> It is hoped that, in the short term, [open schooling - developing partnerships between schools, local communities, civil society organisations, universities and industry] will contribute to a society with more scientifically interested students and a greater awareness of scientific careers. In the medium term, open schooling activities should provide citizens and future researchers with the tools and skills to make informed decisions and choices, and in the longer term, this action should contribute to increasing the number of scientists and research citizens. (OKADA; RODRIGUES, 2018, p. 52).

In this context of openness, where the past and present are permeated with innovative and pioneering concepts that require further exploration, the purpose of this dossier is to provide a dialogic space for all authors, including learners, practitioners, and specialists who have participated in studies with their knowledge, interpretations, and interrelationships, whether exploratory or in-depth, situated in their practices and contexts. The collection of articles presented here serves as a starting point for questioning (CARE), critical scientific reasoning (KNOW), and dialogue with action (DO) to support future research movements and networks focused on sustainability (OKADA; GRAY, 2023). It is hoped that the questions and problematizations raised through the invitation to contribute to this dossier and discussions (see Table 1 below) will lead to new questions and problematizations, such as:

- How can we prepare learners for science and technology to promote life and planet sustainability?
- How can this process be redefined through theoretical and practical lenses?
- What real-life scenarios can facilitate the construction of situated curriculum knowledge and participatory, authentic, critical, and engaging approaches that support science 'with' and 'for' society?

Authors	Acting Subjects in Situated Contexts	Subjects with real problems CARE	Subjects of sciences KNOW	Subjects of technologies DO	Innovative constructions with theoretical / practical lenses
Rabello e Okada	190 students from Kindergarten Elementary school experts and family (Brazil and UK)	Develop projects of Environmental protection led by students to foster multiliteracy	STEM Languages, Geography and Maths	Mobile APP, video, text, infographic, cloud-system, and reflexive questionnaire	Socioscientific education with scientific mediatic and digital multiliteracy, supported by the model CARE-KNOW-DO
Castro e Castro Junior	35 students from Elementary and Middle school (Manaus, Amazonas)	Evaluate the methodological approach of open schooling with citizen science	Natural Sciences, Biology	Smartphones, tablets smartwatch, iNaturalist Reflexive questionnaire	Perspectives of citizen science and open schooling as a continued educational process
Pereira, Struchiner e Merino	3 researchers 1 Chemistry teacher and 33 students	Contextualize the chemistry teaching; Pollution	Natural Sciences, Chemistry	Google Street View,	Contextualized Teaching integrating scientific

Authors	Acting Subjects in Situated Contexts	Subjects with real problems CARE	Subjects of sciences KNOW	Subjects of technologies DO	Innovative constructions with theoretical / practical lenses
	from high school (Rio de Janeiro)	of the River Pavuninha			culture and citizen consciousness
Meister, Lima e Faria	100 students from vocational high school and 10 experts (São Paulo) and 10 specialists (Cruzeiro)	Investigate the design thinking for local problems about inequalities	Applied social sciences	Metaverse, Lab Environment - design, Mobile app SpatialChat	Methodology of design thinking and its applicability on sociocultural actions with open schooling
Sachinski, Kowalski e Torres,	25 students from the New High School and Specialists in Biology, Literature and Design (Paraná)	Reflect about ecological balance; and the hypothetical extinction of the bees	Natural Sciences and Humanities Environment	Padlet Google Forms	Pedagogical practice for creativity, autonomy and protagonists according to the National Curriculum with Open Schooling
Trancoso, Silva e Peixoto	25 students from vocational high school (Bahia)	Investigate the development of computational thinking	Sciences Exact-Maths	Software Scratch	Development of Computational thinking with motivation and students' autonomy
Almeida, Almeida e Silva	Higher Education, Teacher training with about 40 students from postgraduate studies (São Paulo)	Extract some components of open school in the context of Brazilian reality.	Education	websites Videos with Brazilian Sign Language QR codes	Open education for the knowledge with political, territorial, economic and legal.
Furlani, Matta e Costa	Higher Education, 548 teachers, MOOC (Minas Gerais)	Examine the production of Open Educational resources (OER)	Biology, Physics, Chemistry,	MindMeister, Socrative, padlet, form, online game, slides, survey...	Theory-practice in continuing education of teachers with technologies for using OER
Martins	Higher Education, 2 teachers Trainee (Rio de Janeiro)	Develop a pedagogy for hypermobility	Hypermobile Education	Moodle, Blog, Wiki, Seesaw, Google Maps, Symbaloo, Pearltrees, GoConqr	Pedagogy of hypermobility: emergency of teaching devices, research, and authoring
Ribeiro e Santos	1 researcher, 1 group of 60 teachers (Rio de Janeiro)	Explore key challenges in teachers' formation	Online Education	Padlet QR Code	Pedagogy intervention Gallery Walk to the multireferential formation

Fonte: Okada, Rocha and Fluminhan (2023).

The studies presented here highlight issues and solutions related to the real-life experiences of all participating learners, both inside and outside of the school space. They also reflect on research and innovations that

involve students, teachers, citizens, communities, and specialists, with the aim of promoting scientific literacy for sustainability (COMISSÃO EUROPEAN, 2018; HAZELKORN et al., 2015). The innovative research on authentic learning, which focuses on real socio-scientific issues, aligns with open educational practices and the 2030 Agenda (UNESCO, 2015) and addresses global challenges (EUROPEAN COMMISSION, 2018), including the National Common Curriculum Base (BNCC) and the New Secondary Education system in Brazil. The pedagogical scenarios addressed in these studies include contextualized curriculum, interdisciplinary, transdisciplinary, and emancipatory learning environments, community-based participatory research, design thinking, educational design, co-investigation, project-based co-learning, and teacher training in cyberculture.

The scientific studies presented in this dossier comprise quantitative, qualitative, mixed methods, case and multi-case studies, as well as conceptual works that involve research methods and the epistemology of scientific knowledge. They cover various areas of knowledge, including the natural sciences (chemistry, biology, physics), human and social sciences (languages, geography, pedagogy, education, administration, design), and exact sciences (mathematics, computing).

Several emerging technologies are discussed for students to explore through online, offline, hypermobile, hybrid and online learning (FLORIDA, 2015). The examples presented include the production of applications, games, metaverse, coding, citizen science platforms, podcasts, websites, cloud polling systems, smartphones, wearable technologies such as smartwatches and tablets, citizen-science platforms, self-assessment, and co-assessment instruments, including CONNECT-Science.

The works described in this dossier are presented from the perspective of emancipatory practices that promote sustainability with science and emerging technologies, through three educational levels or axes: Axis 1, which pertains to basic education (kindergarten and elementary school); Axis 2, which refers to high school; and Axis 3, which covers higher education (undergraduate and graduate) with a focus on teacher training.

The production of this dossier was a result from the extensive promotion supported by two projects OLAF - open online learning and fun as well as CONNECT - inclusive open schooling with future-oriented science. The large dissemination was led by the organizers, authors, and collaborators in various national and international events, including Educere, Humanitas, Web-Curriculum, IOSTE, SBIE, CIET-ESUD, LSME-London, CONNECT, BETT, and Green Forum UK-BR. Additionally, the dossier was a product of numerous discussions between the organizers and reflections supported by the authors and their networks, which are presented below.

Presentation of the Articles in 3 axes

Emancipatory Practices in Basic Education

Rabello and Okada explore the impact of Open Schooling on the development of multiliteracies in environmental protection projects undertaken by children and young people in Basic Education. The theoretical framework is based on two approaches: socio-scientific education using CARE-KNOW-DO (OKADA; GRAY, 2023) and multiliteracy pedagogy (KALANTZIS; COPE; PINHEIRO, 2020). This qualitative study, utilizing thematic analysis, investigates the open schooling practices of the European-Brazilian CONNECT project in Brazil and the United Kingdom. The findings suggest that students actively develop various literacies, such as digital, mediatic-critical, and scientific literacy, using technologies such as videos, a cloud polling system, editors, and infographics using mobile resources, including a personalized self-assessment application. The study underscores the significance of interdisciplinary and transdisciplinary emancipatory practices, encompassing natural, human, and exact sciences, in educating citizens and professionals as change agents for life and planet sustainability. The study concludes that the multiliteracies acquired by students are crucial for their active and civic involvement in social, digital, and scientific practices via open schooling.

Castro and Castro Júnior's research explores the connection between open schooling and Amazonian biodiversity through citizen science projects that involve the use of technology to engage basic education students in natural science activities. The study found that student involvement is crucial for the success of these projects, and the interplay between citizen science and open schooling creates a more comprehensive educational experience that goes beyond individual projects. To expand students' skills and promote sustainability, it is essential to integrate these open schooling projects into the school curriculum and continue research to better understand their impact.

Emancipatory Practices in High School

The CARE-KNOW-DO model is the object of study by Pereira, Struchiner and Merino. Their article about Chemistry teaching focuses on the pollution of the Pavuninha River in Rio de Janeiro, from the perspective of Science, Technology, and Society (STS). Their emphasis was on critical citizenship education and contextualized teaching. Using the Research in Educational Design (RED) methodology, they analyzed the collaborative construction of pedagogical materials on socio-environmental themes by researchers, a schoolteacher, and her students. Their study showed that this approach motivated and engaged students, improved learning, produced solutions to real environmental problems, and established interrelationships between the curriculum and socio-scientific issues. These results are in line with the STS proposal and the principles of open schooling.

The authors' Meister, Lima and Faria analyse an experience in Design and Education developed at the Experimental Laboratory of Design (LEDE), in the municipality of Cruzeiro, SP, based on design/design thinking developed in contexts of formal and non-formal education. The analysis shows that applying the methodology of design thinking to a context of challenge in search of solutions to a local problem, along with complementary educational actions in metaverses, which are environments where groups of people from different origins and spaces can collaborate using technological means, makes it explicit that groups have the ability to develop solutions, deal with diversity, and value alterity. Finally, the article recommends adopting the methodology of design thinking within the scope of emancipatory education.

Sachinski, Kowalski, and Torres conducted a study on elective disciplines in the New High School as a means of incorporating open schooling into Brazilian education and discussing current topics of interest to students. The analysis focused on activities in a course titled "Between Utopias and Dystopias, History is Made," which was offered as an elective to 1st-year New High School students at a private school in the metropolitan region of Curitiba, PR. Teachers from the areas of Biology and Literature collaborated on the course. The results of an online survey conducted with students revealed that elective courses provide more opportunities for open teaching and learning processes. However, offering such courses requires adequate structural conditions and available teachers within schools.

The article by Trancoso, Silva, and Peixoto aims to investigate computational thinking regarding the functional relationships implicit in the construction of the concept of an affine function, evidenced in students' digital narratives using Scratch software through active methodologies in the 1st year of high school of a technical administration course at a school in Ilhéus, BA. Results show the motivation and involvement of students in learning and indicate the relevant contributions of using Scratch and producing digital narratives to develop computational thinking and understanding the concept of variables and the affine function. Such evidence suggests the relevance of disseminating the knowledge produced by this research among researchers and, especially, with Basic Education teachers.

Teacher training in Higher Education

The article by Almeida, Almeida, and Silva deals with the concepts of open education and open schooling, emphasizing theories presented in the literature and public policy documents of recent decades. Additionally, inspired by the Responsible Research and Innovation approach, it analyses projects developed by students of a graduate program. The authors present that open education for teacher training is related to knowledge of political, territorial, economic, and legal dimensions, and is linked to institutional frameworks and intentions to provide accessibility for all. This conclusion highlights the evolution of the concept of open education and its convergence with open schooling and the 2030 Agenda of the United Nations (UN).

The article by Furlani, Matta, and Costa examines the challenges and insights gained in creating learning objects for open schooling. Specifically, the research focuses on didactic materials developed as learning objects (LOs) by teachers participating in a distance course offered by a university in Minas Gerais, Brazil. Analysis of the LOs in the natural sciences field indicated positive evaluations in didactic-pedagogical aspects, but they could not be considered as Open Educational Resources (OERs) because they were not published with a license for use. The course helps bridge the theory-practice gap in teacher continuing education, but hurdles remain in creating and sharing OERs. Thus, while open education and open schooling share some characteristics, there is still a long way to go to achieve the goals of open schooling in practice.

Martins explores the concept of hypermobility pedagogy within the context of teacher training in cyberculture. This was studied in courses at the Federal Institute of Rio de Janeiro, adopting research training in cyberculture as a method to intertwine research with teaching practice. Through reflection on experiences in research-training contexts, the author developed the concept of hypermobility pedagogy, which is characterised by seven subsuming notions: problematising existence that changes the world; interactive, inventive, and experiential education; education-world; education on the go; connected education; personalised and contextualised education; and hope for a new world. By recognising which pedagogical practices of teachers and researchers should be considered for a hypermobility pedagogy with experiences in movement, this approach can be developed through connection, mobility, and the establishment of relationships with their communities.

The article by Ribeiro and Santos discusses how the use of a virtual gallery called "Gallery Walk Online" was applied to training of teacher trainers during the COVID-19 pandemic in Rio de Janeiro. The authors argue that this virtual gallery allowed them to understand how teacher trainers were formed through the elaboration and sharing of narratives in the light of the notion of open schooling. They also suggest that this training has the potential to produce knowledge for teachers who train this teaching network, by exploring the connections and possibilities of hypermedia, interactivity, collaboration, co-creation, and hypertextuality.

Concluding Remarks

Considering the range of topics, subjects, methodologies, and technologies explored in this dossier, as well as the diverse educational contexts examined, the articles provide valuable insights and findings that can inform reflections on pathways to emancipatory education with sustainable teaching and learning practices.

These exploratory studies on pioneering themes are important for advancing research and fostering alignment, clarity, and coherence of concepts, which in turn can enhance the visibility, appreciation, and adoption of these ideas. However, there is a need for further research to deepen and expand our understanding of these topics, as well as to ensure their wider dissemination and application.

Acknowledgements

References

COMISSÃO EUROPEIA. Open schooling and collaboration on science education. Disponível em: https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-search;callCode=H2020-SwafS-2018-2020. Acesso em: 09 jan. 2023.

FLORIDI, L. (2015). The onlife manifesto: Being human in a hyperconnected era (p. 264). Germany: Springer nature, 2015.

FREIRE, P. *Role of education in humanization*. São Paulo: Series Articles, 1967.

FREIRE, P. *Cultural action for freedom*. 7. ed. Rio de Janeiro: Peace and Earth, 1984.

FREIRE, P. *Pedagogy of autonomy*: knowledge necessary for educational practice. 9. ed. São Paulo: Peace and Earth, 1996.

FREIRE, P. *Pedagogy of hope*: a reunion with the pedagogy of the oppressed. 16. ed. Rio de Janeiro: Peace and Earth, 2009.

HAZELKORN, E. *et al. Science Education for Responsible Citizenship, Report to the European Commission of the expert group on science education Okada, Alexandra*. CARE-KNOW-DO framework. Milton Keynes: Open University, 2020.

HODSON, D. Looking to the future. *Springer Science & Business Media*, 2011.

OKADA, A.; SHEEHY, K. The value of fun in online learning: a study supported by responsible research and innovation and open data. *Revista e-Curriculum*, v. 18, n. 2, p. 319–343, 2020.

OKADA, A.; SHERBORNE, T. Equipping the Next Generation for Responsible Research and Innovation with Open Educational Resources, Open Courses, Open Communities and Open Schooling: An Impact Case Study in Brazil. *Journal of Interactive Media In Education*, v. 1, n. 18, p. 1–15, 2018.

OKADA, A.; ROCHA, A.; FLUMINHAN. C. Releitura do Dossiê "Práticas Emancipatórias Abertas para Sustentabilidade com Ciência e Tecnologias Emergentes. CONNECT-Science.net blog post.

OKADA, A.; GRAY, P. A Climate Change and Sustainability Education Movement: Networks, Open Schooling, and the 'CARE-KNOW-DO' Framework. *Sustainability*, v. 15, n. 3, article no. 2356, 2023.

RATCLIFFE, M.; GRACE, M. *Science education for citizenship: Teaching socio-scientific issues*. UK: McGraw-Hill Education, 2003.

UNESCO. *UNESCO and Sustainable Development Goals*, 2021. Disponível em: https://en.unesco.org/sustainabledevelopmentgoals. Acesso em: 24 maio 2023.