CONNECT

Students & scientists solving
real-problems

Inclusive
Open Schooling

with engaging and future-oriented science

Evidence-based Practices, Principles & Tools

Alexandra Okada | Editor

www.connect-science.net

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Open
Schooling
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CONNECT
Students & scientists solving
real-problems

SUSTAINABLE
DEVELOPMENT
GOALS

CONNECT supports the Sustainable Development Goals
and the Open Schooling Together network

The future we choose.

Christiana Figueres and Tom Rivett-Carnac
UNESCO Paris Agreement

Inclusive Open Schooling with engaging and future-oriented science

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To our children and the next generations at the heart of everything that matters.

Care-Know-Do

Inclusive Open Schooling with Engaging and Future-Oriented Science is a timely and essential book that sheds light on the transformative power of education in shaping the minds of our future generations. In an ever-evolving world, where technological advancements and global challenges are reshaping our societies, it is imperative that our educational systems adapt to prepare students for the complex realities they will face; helping them identify what issues they care about, what they need to know and actions they need to do in order to develop competences along life.

This book explores the concept of inclusive open schooling, a ground-breaking approach that promotes equal opportunities for all learners while embracing the principles of openness, collaboration, and innovation. By breaking down barriers and fostering a sense of belonging, inclusive open schooling creates an environment where every student can thrive and excel.

At the heart of this educational paradigm lies the subject of science, which acts as a catalyst for curiosity, critical thinking, and problem-solving skills. Inclusive Open Schooling with Engaging and Future-Oriented Science emphasizes the importance of equipping students with scientific literacy and the ability to apply scientific knowledge to real-world challenges. It goes beyond the traditional boundaries of science education, encouraging interdisciplinary learning and cultivating essential skills such as reasoning, creativity, and teamwork.

Through insightful research, evidence-based practices, and thought-provoking discussions, this book navigates the terrain of inclusive open schooling and its transformative impact on science education with cross and trans disciplinary scenarios connected to EU missions and UNESCO sustainable development goals. It highlights the need for educational institutions to embrace a broader perspective, focusing not only on exam-driven outcomes but also on nurturing a deep understanding of scientific concepts and a genuine passion for learning.

The authors, experts in their fields, provide a roadmap for educators, policymakers, and stakeholders to reimagine the possibilities of education. They present innovative approaches, evidence-based strategies, and compelling case studies that demonstrate the effectiveness of inclusive open schooling in fostering engagement, relevance, and future-readiness.

As we embark on this journey towards inclusive open schooling with engaging and future-oriented science, let this book serve as a guiding light, inspiring us to embrace new paradigms, challenge traditional norms, and unlock the full potential of every learner. Together, let us create a world where education is not only accessible to all but also empowers individuals to shape a better future for themselves and their communities.

Dr Alexandra Okada
Scientific Coordinator
of CONNECT

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“Open schooling focused on how we could look into science education going forward, taking into consideration new global challenges.”

Karen Slavin,
European Commission

Source: Interview provided
to OS Together network

Open Schooling for all

Contemporary education plays a crucial role in empowering young people with scientific thinking to shape a sustainable world. To cultivate a scientifically literate society, it is imperative to introduce young individuals to science at an early age, encouraging exploration, construction, and application of scientific principles in their daily lives and future career paths. Connecting science to young people's lives through inclusive, engaging and future-oriented learning approaches is key to inspire future generations to help build a desirable future. Developing scientific thinking skills is essential for enabling young people to become independent learners capable of comprehending and applying science in a way that benefits themselves, society, and the planet (Hodson, 2011).

However, the traditional curriculum often leads to a significant number of students feeling disconnected from science, in particular the unwillingness to aspire science careers. Research on science capital (Moote, Archer, DeWitt, MacLeond, 2021) sheds light on this issue, suggesting that these students lack cultural familiarity with science and adequate role models, particularly affecting those from disadvantaged backgrounds. Limited opportunities to engage with science beyond formal education contribute to their inability to envision themselves as future scientists.

Both goals of science education: preparing generations as responsible citizens and science careers, are relevant for all students. It is essential to implement strategies that bridge the gap and foster inclusivity. This includes creating learning environments that embrace diverse cultural perspectives, providing opportunities for students to engage with science in practical, hands-on ways, and showcasing diverse role models from various backgrounds who have excelled in scientific fields. By broadening participation and dismantling the perception that science is exclusive to certain groups, we can inspire a greater number of young individuals to pursue and succeed in scientific endeavours as professionals and citizens, regardless of their socioeconomic or cultural background.

With this goal in mind, the recent term "Open Schooling" means partnerships bringing together students with teachers, scientists and professionals, family members and policymakers for solving significant real-life challenges that they care about, discuss innovations supported by scientific education, cocreate knowledge and do actions for local community development. It is considering a key approach for education aligned with the AGENDA 2030 to enhance wellbeing, sustainability, and a desirable future for all (UNESCO, 2021).

The definition of Open Schooling was introduced in the report "Science Education for Responsible Citizenship" promoted by the European Union in 2015. It highlights the importance of cooperation between schools, families, universities, and enterprises for students to learn with real-life projects.

> *"Open schooling" where schools, in cooperation with other stakeholders, become agents of community well-being. Families are encouraged to become real partners in school life and activities. Professionals from enterprise, civil and wider society are actively involved in bringing real-life projects into the classroom. (Hazelzorn et al., 2015, p.10)*

Open schooling was coined by an expert panel when considering that Europe faces a shortfall in science-knowledgeable people at all levels of society (Hazelkorn et. al., 2015). This is also occurring in other continents. A crucial need of governments is to foster a science literate society through a meaningful learning continuum for all. To sustain the movement of responsible research and innovation supported by science "with", "for" and "by" society, another critical need is to increase the number of scientists for green lives, green jobs, and green societies (Okada, Grey, 2023).

> *"Science education should be an essential component of compulsory education for all students. Policies should support students, teachers, parents, and the wider community to improve access to and provide everyone with the opportunities to pursue excellence in learning and learning outcomes and to ensure young people and adult learners alike are motivated to learn and to be fully equipped to engage in scientific discourse and facilitate further study in science education." (EC, 2023)*

Over the past five years, more than 15 projects were funded by various European Union programmes, totalling more than 35 million euros. These initiatives have primarily focused on developing strategic actions, investigating how to design, implement, refine, and scale up open schooling for both the current and future generations.

Considering the post-pandemic environment and the green digital transition, new priorities for open schooling have recently emerged:

1. Establishing partnerships in science and technology across diverse learning environments, including educational institutions, workplaces, and societal organisations, with a focus on the Green Deal, Health, and Digitalization.

2. Building cross-community networks of stakeholders, emphasising the promotion of inclusion, diversity, and equity with a specific objective to boost female participation.

3. Encouraging engagement in enterprise-funded innovation as part of lifelong learning programs. This involves start-ups and SMEs to entrepreneurs - all supported by mentorship and coaching opportunities.

Open schooling initiatives have started a significant movement by fostering an increasing number of tangible partnerships, leveraging resources, methodologies, and technologies to cultivate sustainability. However, the CONNECT project argues that the key to this advancement lies in integrating more opportunities into the national curriculum supported by the government, a right for all students to engage with scientific fields, cocreate knowledge, develop skills, communicate about science within their familial circles, and understand the profound impact of science on the world.

One pivotal challenge under exploration is the creation of sustainable and continually updated open schooling networks.

The purpose of this book is to provide evidence-based outputs developed in the project CONNECT to influence policy and raise the debate about how to make open schooling sustainable and scalable. This book also promotes other open schooling initiatives and invites everyone to support the open schooling movement.

The EU missions

The European Commission (2021) has outlined several key missions as part of its Horizon Europe research and innovation program. These missions are ambitious goals aimed at addressing major societal challenges and driving sustainable development. The five European missions are as follows:

1. **Cancer:** Conquering Cancer: Mission Possible: This mission focuses on preventing, treating, and curing cancer, improving the quality of life for patients, and promoting cancer prevention strategies.
2. **Climate Change:** Adapting to climate change, including societal transformation: This mission aims to make Europe the first climate-neutral continent by 2050 and accelerate the transition to a sustainable, resilient, and climate-resilient society.
3. **Healthy Oceans, Seas, Coastal and Inland Waters:** This mission focuses on achieving a pollution-free, healthy, and resilient marine and freshwater ecosystem, ensuring sustainable use of resources, and fostering a blue economy.
4. **Climate-Neutral and Smart Cities:** This mission aims to make all European cities climate-neutral by 2030 and enhance their sustainability, resilience, and quality of life through smart and innovative solutions.
5. **Soil Health and Food:** This mission focuses on ensuring healthy, sustainably produced food while protecting and restoring soil health, aiming to secure sufficient and nutritious food for a growing global population.

These missions represent the European Union's commitment to addressing critical challenges through research, innovation, and collaboration. They seek to mobilize resources, expertise, and stakeholders across Europe to achieve transformative and impactful outcomes.

CONNECT project considers that integrating the open schooling approach with the European Union's missions can add significant value to the education system and contribute to the EU's broader goals.

Open schooling emphasizes colearners-centered approach to education, which aligns well with the objectives of the EU missions. By connecting open schooling principles with the missions, the following benefits can be realized:

1. **Enhanced Relevance:**
   Open schooling can be tailored to address the specific challenges and priorities identified by the EU missions. By incorporating mission-related content and activities into the curriculum, students can develop a deeper understanding of the issues at hand and acquire the necessary knowledge and skills to contribute to their resolution.

2. **Active Citizenship:**
   Open schooling encourages active engagement, critical thinking, and problem-solving skills among students. By aligning open schooling initiatives with the EU missions, students can become active citizens who are aware of the challenges faced by the EU and are empowered to contribute to positive change in their communities and society.

3. **Interdisciplinary Learning:**
   EU missions often require interdisciplinary approaches to address complex issues. Open schooling promotes interdisciplinary learning by integrating different subject areas and encouraging collaboration among students. This interdisciplinary focus can help students develop a holistic understanding of the mission-related topics and foster innovative thinking.

4. **Collaboration and Partnerships:**
   Open schooling encourages collaboration between educational institutions, communities, and various stakeholders. By linking open schooling initiatives with EU missions, partnerships can be formed with relevant organizations, institutions, and experts working in the respective fields. This collaboration can provide valuable resources, expertise, and real-world perspectives, enriching the learning experience for students.

5. **Future-oriented Skills:**
   The EU missions aim to tackle current and future societal challenges. Open schooling emphasizes the development of future-oriented skills such as critical thinking, creativity, digital literacy, and sustainability awareness. By aligning open schooling with the missions, students can acquire the necessary skills and competencies to actively contribute to the EU's goals and adapt to the evolving needs of society.

The European Union's five missions are closely aligned with the 17 Sustainable Development Goals (SDGs) established by the United Nations. While the missions focus on specific areas of societal challenges within Europe, they share common objectives and contribute to the broader global agenda of sustainable development. Each mission can be linked to one or more SDGs, as they address various aspects of sustainability and development. For example:

- The Cancer mission aligns with SDG 3 (Good Health and Well-being), which aims to ensure healthy lives and promote well-being for all at all ages.

- The Climate Change mission is connected to SDG 7 (Affordable and Clean Energy), SDG 11 (Sustainable Cities and Communities), and SDG 13 (Climate Action). It focuses on mitigating climate change, promoting renewable energy, and creating sustainable and resilient cities.

- The Healthy Oceans mission relates to SDG 14 (Life Below Water), which seeks to conserve and sustainably use marine resources, while contributing to SDG 6 (Clean Water and Sanitation) and SDG 15 (Life on Land).

- The Climate-Neutral and Smart Cities mission aligns with SDG 11 (Sustainable Cities and Communities), aiming to make cities inclusive, safe, resilient, and sustainable.

- The Soil Health and Food mission is connected to SDG 2 (Zero Hunger) and SDG 15 (Life on Land), as it focuses on sustainable food production, promoting biodiversity, and protecting ecosystems.

The European missions and the SDGs share the common vision of promoting sustainability, addressing global challenges, and achieving a more inclusive and prosperous future for all. They provide a framework for guiding policies, research, and collaborative efforts at both the regional and global levels. By working towards the missions, the European Union contributes to the broader global agenda of achieving the SDGs.

Open schooling approach connected with the EU missions and SDG can enhance the relevance, effectiveness, and impact of education in addressing the challenges. By nurturing active citizenship, interdisciplinary learning, collaboration, and future-oriented skills, open schooling can contribute to the mission-driven agenda of various nations and empower students to become agents of positive change.

"Open Schools: building a new school for the 21st century — one which typifies "school as a function" rather than "school as a location". This means a school which truly contributes to the holistic and human development of its students and the community".

Marlova Noleto
Director of UNESCO Brasil

Sustainable Development goals

Engaging youth with sustainability is essential for nurturing future leaders, fostering innovation, ensuring long-term impact, promoting diversity, building capacity, and embracing interconnectedness. By involving young people in the pursuit of the sustainable development goals, we pave the way for a more sustainable and inclusive future.

Sustainability, according to UNESCO, means that we should meet our needs today without harming the ability of future generations to meet their own needs. It's about finding a balance between social, economic, and environmental factors to ensure the well-being of everyone now and in the future.

- **Social Sustainability:**
  This is about fairness and equality. It means making sure that everyone has access to education, healthcare, and basic services, no matter who they are. It also means respecting and preserving different cultures and promoting peaceful and inclusive societies.

- **Economic Sustainability:**
  This is about having a strong and fair economy that benefits everyone. It means using resources responsibly and making sure that economic growth doesn't harm the environment or leave people behind. It involves creating jobs, supporting sustainable businesses, and promoting fair trade.

- **Environmental Sustainability:**
  This is about taking care of our planet. It means protecting nature, preserving biodiversity, and using resources wisely. It's about reducing pollution, fighting climate change, and finding sustainable ways to produce and consume energy, water, and other resources.

All three aspects of sustainability are connected and need to work together. Youth need to think holistically and consider how our actions in one area impact the others. By embracing sustainable development, UNESCO (2021) aims to create a better and more balanced world for both current and future generations. The Sustainable Development Goals (SDGs), also known as the Global Goals, are a set of 17 goals adopted by the United Nations in 2015.

They serve as a blueprint for achieving a more sustainable and equitable world by the year 2030.

The CONNECT project considers that supporting the SDGs with science gives youth a voice, agency, and the opportunity to make a meaningful difference in the world. It allows them to contribute to building a more sustainable, just, and prosperous future for all with scientific thinking. The SDGs provide a comprehensive framework for governments, organisations, businesses, and individuals to work together and take concrete steps towards creating a more sustainable and inclusive future for all.

Connecting open schooling to the SDGs provides a framework for transformative education that prepares students to become informed, responsible, and active global citizens committed to building a more sustainable and equitable world. Open schooling should be connected to the SDGs for six reasons.

1. **Holistic Education:**
   Integrating SDGs into open schooling provides a comprehensive education beyond academic subjects, equipping students to address real-world challenges.
2. **Contextualization and purpose:**
   SDG-aligned open schooling offers relevant learning experiences, fostering students' understanding of the goals' significance and their responsibility for sustainable development.
3. **Global-Local Citizenship:**
   Open schooling connected to SDGs promotes global citizenship, fostering interconnectedness, cultural awareness, and empathy for diverse communities.
4. **Skills for the Future:**
   SDG-aligned open schooling develops critical thinking, problem-solving, collaboration, and innovation skills, preparing students for a sustainable and inclusive future.
5. **Active Empowerment:**
   Open schooling linked to SDGs empowers students to actively engage in projects that contribute to the goals, enabling them to make a positive impact.
6. **Education for Sustainable Development:**
   Integrated with SDGs, open schooling supports Education for Sustainable Development principles, fostering understanding of interconnected issues and encouraging sustainable practices.

The Inner development goals

Inner development goals (IDGs) refer to personal growth and self-improvement objectives that focus on enhancing one's internal qualities, mindset, and well-being. These goals are centred around developing qualities such as self-awareness, emotional intelligence, resilience, mindfulness, and personal values. Inner development goals are often related to personal fulfilment, happiness, and overall psychological well-being. The innerdevelopmentgoals.org initiative includes five key areas of personal development and skills that contribute to wise decision-making to create positive change in the world (Jordan et. al., 2021).

1. **Being – Relationship to Self:** This involves cultivating self-awareness, integrity, authenticity, openness, and presence. It emphasizes developing a deep connection with one's thoughts, feelings, and body to navigate complexity effectively.

2. **Thinking – Cognitive Skills:** Developing cognitive skills is crucial for wise decision-making. It includes critical thinking, complexity awareness, perspective-taking, sense-making, and long-term orientation. These skills help in evaluating information, understanding systemic conditions, and creating coherent narratives.

3. **Relating – Caring for Others and the World:** This aspect focuses on appreciating and feeling connected to others and the environment. It involves qualities such as appreciation, connectedness, humility, empathy, and compassion. By caring for others and the world, we can contribute to creating just and sustainable systems and societies.

4. **Collaborating – Social Skills:** Effective collaboration requires skills in communication, co-creation, inclusivity, and trust-building. These skills enable individuals to listen, advocate their views, manage conflicts constructively, and work with diverse stakeholders towards shared goals.

5. **Acting – Enabling Change:** This involves qualities like courage, creativity, optimism, and perseverance. By embodying courage, individuals can challenge existing structures and generate original ideas. Optimism and perseverance help to sustain hope, positive attitudes, and determination when faced with uncertainty and challenges.

Open Schooling to enhance SDG and IDG

The relationship between Inner Development Goals (IDGs) and the Sustainable Development Goals (SDGs) is that IDGs are an individual or personal approach to self-development that can contribute to the achievement of the broader SDGs. The SDGs are a set of 17 global goals adopted by the United Nations in 2015, aiming to address pressing social, economic, and environmental challenges and achieve sustainable development by 2030. The SDGs provide a framework for countries and organisations to work towards a more equitable, inclusive, and sustainable future. On the other hand, Inner Development Goals (IDGs) focus on personal growth, well-being, and self-improvement. They involve cultivating qualities such as self-awareness, empathy, compassion, resilience, and mindfulness. IDGs encourage individuals to develop a deeper understanding of themselves, their values, and their interconnectedness with others and the world. While IDGs may seem individual-focused, they have a significant impact on the broader goals of sustainable development. When individuals cultivate inner qualities and engage in personal growth, it can lead to positive changes in their attitudes, behaviours, and actions towards the environment, society, and other people. These changes can then contribute to achieving the SDGs by promoting social justice, environmental stewardship, and sustainable practices. In addition, while the SDGs provide a comprehensive framework for global sustainable development, IDGs focus on personal growth and inner transformation. The relationship between the two lies in the understanding that personal development can lead to positive contributions towards achieving the broader goals of sustainable development outlined in the SDGs.

Open schooling can promote both SDGs and IDGs by providing accessible education, supporting lifelong learning, offering flexibility and personalization, fostering holistic development, emphasising real-world relevance, and nurturing local and global citizenship values. By aligning open schooling practices with the principles of sustainable development and personal growth, it creates opportunities for individuals to contribute to a more sustainable, inclusive, and harmonious world. Open schooling has the potential to promote both SDGs and IDGs through its inclusive, learner-centred, and holistic approach to education with six key benefits.

1. **Accessible Education:**
   Open schooling aims to provide education to all, including marginalised and underserved populations. By ensuring access to quality education, open schooling contributes to SDG 4 (Quality Education) by promoting inclusive and equitable learning opportunities for all individuals, regardless of their backgrounds or circumstances.

2. **Lifelong Learning:**
   Open schooling emphasises lifelong learning, recognizing that education is not limited to formal school settings. It encourages continuous personal growth, skill development, and knowledge acquisition aligned with SDG 4. It supports IDGs by fostering a culture of self-improvement, self-reflection, and ongoing learning.

3. **Flexibility and Personalization:**
   Open schooling offers flexibility in terms of pace, time, and learning pathways. It recognizes that individuals have different needs, interests, and learning styles. Open schooling supports IDGs by enabling individuals to explore their passions, develop their unique talents, and pursue their own learning goals.

4. **Holistic Development:**
   Open schooling goes beyond academic learning and emphasises holistic development, including physical, emotional, social, and ethical aspects. It promotes well-being, resilience, and character development. By nurturing the whole individual, open schooling contributes to IDGs by supporting personal growth, self-awareness, and the development of positive values and attitudes.

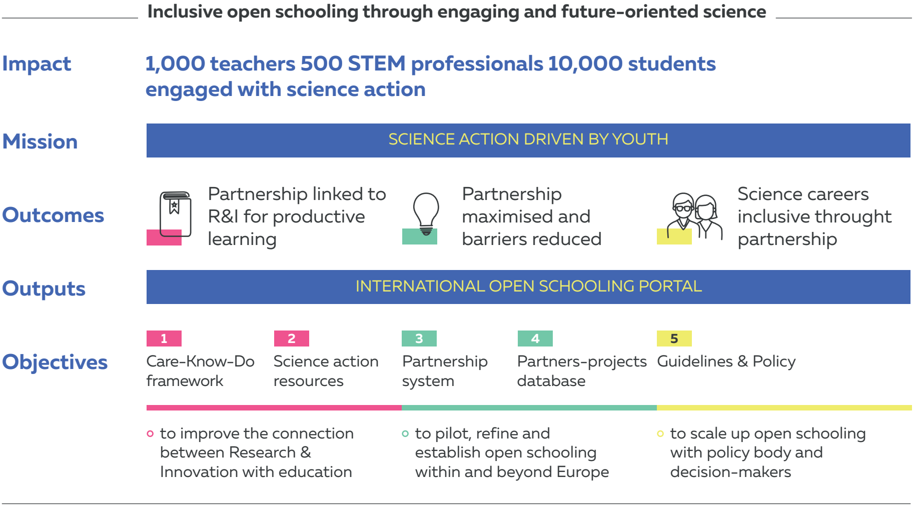
5. **Real-World Relevance:**
   Open schooling often incorporates real-world experiences, practical applications, and community engagement. It connects learning to real-life contexts and encourages problem-solving, critical thinking, and creativity. By emphasising the practical application of knowledge and skills, open schooling supports SDG 4 and IDGs by preparing individuals to actively contribute to their communities and address real-world challenges.

6. **Global Citizenship:**
   Open schooling fosters global awareness, cultural understanding, and empathy. It promotes intercultural dialogue, respect for diversity, and the appreciation of different perspectives. By nurturing global citizenship values, it contributes to SDG 4 and IDGs by encouraging individuals to be responsible, compassionate, and engaged global citizens who strive for social justice, peace, and sustainability.

Inclusive Open Schooling with engaging and future-oriented science

CONNECT Project

CONNECT: *Inclusive Open Schooling through Engaging and Future-oriented Science (Figure 1)* is a project funded by European Union for enabling secondary schools to adopt open schooling by embedding science-action driven by youth in the core curriculum through engaging, participatory approaches. A science-action makes science more relevant to students by showing them how scientific research and innovation can positively affect their lives, and how they can use science to make a positive impact as young researchers whilst still at school. An important part of a science-action is giving students, including underserved learners, the opportunity to interact with STEM professionals, as well as having opportunities to discuss science issues at home.



Inclusive open schooling through engaging and future-oriented science

Impact **1,000 teachers 500 STEM professionals 10,000 students engaged with science action**

Mission SCIENCE ACTION DRIVEN BY YOUTH

Outcomes

- Partnership linked to R&I for productive learning
- Partnership maximised and barriers reduced
- Science careers inclusive throught partnership

Outputs INTERNATIONAL OPEN SCHOOLING PORTAL

Objectives

1. Care-Know-Do framework
2. Science action resources
3. Partnership system
4. Partners-projects database
5. Guidelines & Policy

- to improve the connection between Research & Innovation with education
- to pilot, refine and establish open schooling within and beyond Europe
- to scale up open schooling with policy body and decision-makers

Figure 1: CONNECT Project.

The CONNECT project is designed to foster the creation of flexible, inclusive, and sustainable learning activities within schools, inspiring students, and others to explore the world through the lens of science. To achieve this, The CARE-KNOW-DO pedagogy encourages students to identify real-world problems they care about and apply scientific knowledge to solve them collaboratively. This involves integrating science-action into the curriculum and engaging families, universities, and enterprises in participatory science activities. This immersive approach extends learning beyond the classroom and throughout life.

Partnerships for transformation

The CONNECT consortium includes ten organisations and their networks in four European nations: Greece, Spain, Romania, and the United Kingdom, as well as the largest country in South America, Brazil.

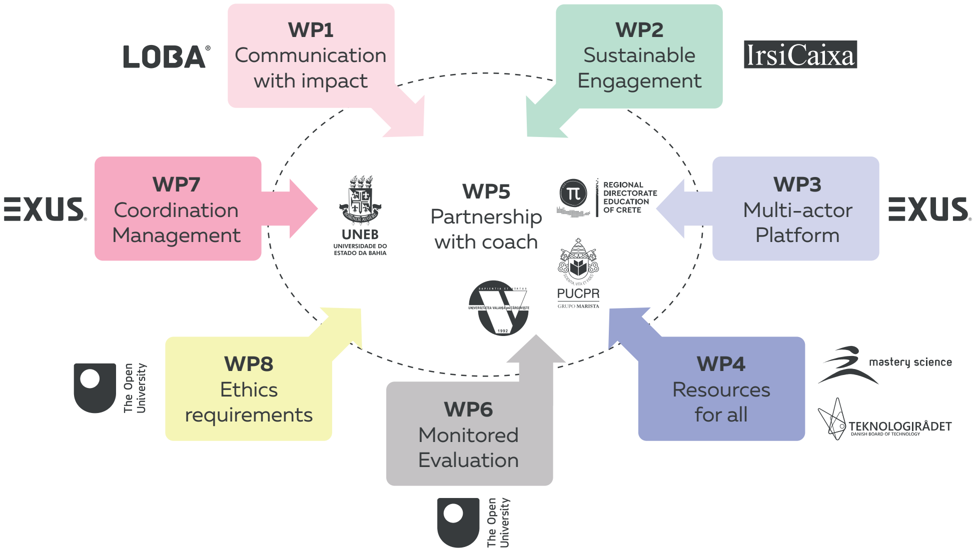

LOBA
WP1 Communication with impact
WP2 Sustainable Engagement
IrsiCaixa
EXUS
WP7 Coordination Management
UNEB Universidade do Estado da Bahia
WP5 Partnership with coach
Regional Directorate Education of Crete
WP3 Multi-actor Platform
EXUS
PUCPR Grupo Marista
The Open University
WP8 Ethics requirements
WP6 Monitored Evaluation
WP4 Resources for all
mastery science
TEKNOLOGIRÅDET Danish Board of Technology
The Open University

Figure 2: CONNECT Consortium.

Three enterprises are experts in AI technologies, communication, and science curriculum design. Two not-for-profit corporate foundations serve as a living lab in health and a participatory foresight centre. Four universities lead open schooling partnerships across natural sciences, social sciences, and formal sciences. A national network of schools under the Greek Government's purview focuses on fostering innovation at all levels of schooling (See Figure 2).

Our objective is to drive positive transformations in science education for and with society through open schooling across the aforementioned countries. The seven partners implementing open schooling left a significant legacy with the establishment of learning ecosystems in five countries. This achievement involved the development and improvement of research evaluation instruments, participatory methodologies, curriculum frameworks, and approaches to co-create open schooling educational resources.

The legacy of CONNECT was solidified with the support of three partners who coordinated the project, digital platform, communication, and the advisory board feedback. The positive outcomes of our project at global and local levels have enabled transformations not only within our networks of multi-stakeholders, but also internally in our careers and organisations. The following examples showcase some of these accomplishments.

Transformations of partners who implemented Open Schooling

The Open University has strengthened its position as a leader in evaluation and ethics frameworks, investigating students' connection with science in their lives with the growth of their science capital and affective engagement. Its novel research instruments, firmly rooted in the CARE-KNOW-DO model, enabled data analysis from more than 12,000 students and 1,000 teachers, providing substantial evidence that has contributed to the improvement of curriculum, teaching methods, learning experiences, and research with open science.

Mastery Science, a publisher specialising in educational resources, has successfully developed a proof-of-concept for creating inclusive, engaging, and future-oriented educational materials for open schooling. These resources are aligned with national curricula in five countries. Currently, the team at Mastery Science is leading the design of a new qualification in the UK called "Science in Practice", which is supported by open schooling principles.

Living Lab IRSICAIXA enhanced its leadership in stakeholder engagement through the development of a key approach "system-oriented model dialogue" underpinned by Participatory Action Research. They also produced the catalogue of inspiring resources and the engagement toolkit for organisations to implement effective public engagement.

Valahia University of Targoviste played a leading role in developing professional development programs for educators in open schooling. The model, based on various well-grounded approaches, enabled personalised and flexible teacher training. It catered to both individuals and group/peer coaching and had a significant impact in five countries.

RDE expanded their knowhow and innovation with the development of a framework for stakeholders to produce open schooling resources underpinned by the CARE-KNOW-DO pedagogical principles. They created significant opportunities for open schooling learners to act as scientists with various types of science-action projects.

UNEB and PUC-PR have increased the impact and know-how with the open schooling initiatives in the north and south of Brazil supported by local authorities from the government at the early stage. The success of science-action projects, evidence-based gains for students and teachers underpinned by data, and the recognition and certification of real-life science learning skills were key for scalability.

Transformations of partners with who supported the implementation

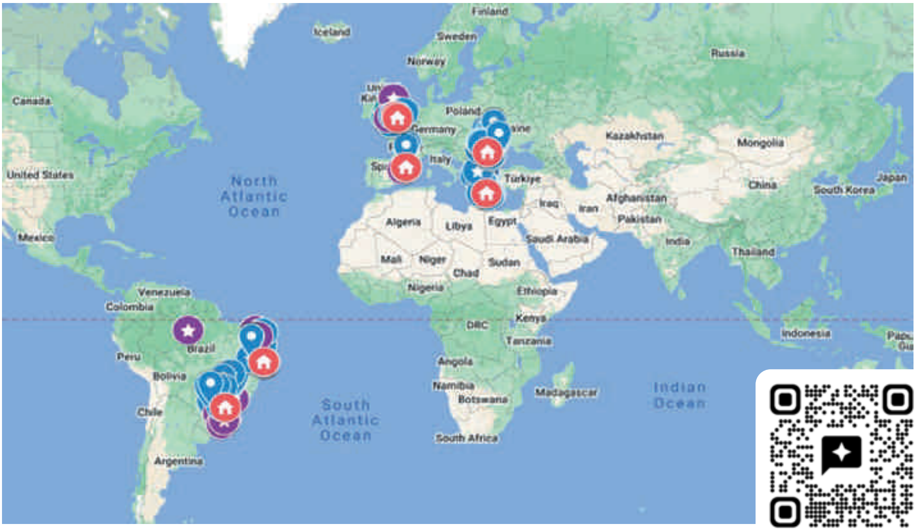
EXUS AI Labs, the project coordinator and technology leader, innovated their portfolio and proficiency in a multi-actor platform with more than 2,000 users that facilitates open schooling and citizen science initiatives. The multi-language platform enabled various activities such as meetings, peer learning, peer counselling, resource dissemination, and accreditation.

LOBA, responsible for communication, enhanced its portfolio with relevant insights and know-how about open schooling, with a powerful website including various campaigns (more than 20,000 users on social media) to promote best practices among schools, teachers, students, and scientists.

DBT coordinating the user advisory board and participatory tools amplified their expertise in the sphere of formal and non-formal education in and outside schools with authentic approaches for RRI including participatory technology assessment for school education. They adapted their co-authored 2020 engagement methods funded by the EU Horizon into open-ended Science Educational Resources for open schooling.

Evidence-based outcomes

The CONNECT consortium dedicated its efforts to a substantial group of 30,000 students across five countries, consisting of four European nations: Greece, Romania, Spain, and the UK, as well as one South American country, Brazil. Despite encountering unforeseen challenges due to the pandemic, CONNECT successfully surpassed the barriers with the implementation of a large number of open schooling initiatives, exceeding its target. We were expected to generate data from 15% of the overall target (4,500 students) and excelled with more than 16,000. If students had access to technologies and the internet as part of their daily lessons, the number would be much higher. Several students had to share digital devices to complete the evaluation in their schools, and many were unable to respond at home due to the lack of an internet connection.


Finland
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Italy
United States
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Iran
Afghanistan
China
South Korea
Japan
Pakistan
Mexico
Algeria
Libya
Egypt
Saudi Arabia
India
Thailand
Mali
Niger
Chad
Sudan
Nigeria
Ethiopia
Venezuela
Colombia
Kenya
DRC
Tanzania
Indonesia
Brazil
Peru
Bolivia
Angola
Namibia
Botswana
Madagascar
Indian Ocean
Chile
South Atlantic Ocean
South Africa
Argentina

Map 1: CONNECT network of open schooling research schools.

CONNECT's accomplishment is showcased through various mixed-methods case studies and quantitative data, supported by the creation of a multi-language reflective self-reported instrument with open science and personalised feedback. This led to a comprehensive evidence-based database with automated personalised reports for all stakeholders, including geographical, age, and gender differences. Our data generation reflects the partners' remarkable achievement in obtaining students' and teachers' views (Map 1) and underscores their efficient commitment to generating impactful research.

Our mission: Underserved Students

CONNECT's mission focuses on underserved students, those from lower socioeconomic backgrounds, including children of migrants, youth attending schools located in underprivileged neighbourhoods', and those with limited access to digital devices and the internet (Guerin, 2013:2; Jennings, 2018; EuroStat 2020). Our participants also include a large number of students whose parents do not have jobs that use science.

During the first phase of the CONNECT project in 2021, a consortium engaged 1,000 students from five countries. Their task was to design the CARE-KNOW-DO open schooling model and implement and evaluate a pilot adoption. In the subsequent phases (phase 2 and 3) from 2022 to mid-2023, CONNECT was implemented in over 500 schools, involving more than 30,000 students. The project has been supported by strong evidence-based results and aims to sustain networks and expand its impact in the next six months. The consortium's achievements have been outstanding, with data collected from over 12,000 students representing various age groups, genders, and locations, including urban, rural, and remote areas. These students self-assessed their science capital in four components: what they do, what they know, how they think, and who they know. They also reported on their learning experiences and feelings towards science. The data collected has allowed the consortium to explore underserved students' science capital and emotional engagement with science. The project is committed to inclusive open schooling for all with open, engaging and future-oriented science.

The European Commission Recommendation 'Investing in Children – Breaking the Cycle of Disadvantage (2013)' emphasises one of the key objectives of the Europe 2020 strategy: to uplift 20 million students out of poverty and social exclusion by enhancing educational outcomes and increasing access to higher education. Literature shows that schools in disadvantaged areas have five challenges (Fink 2017; Agasisti et. al., 2021).

1. **Additional learning needs:** teachers report a lack of educational resources for lower ability students, and it is time-consuming to create their own resources.

2. **Material poverty:** students lack learning resources at home, such as reference books and computers.

3. **Emotional climate and disturbed behaviour:** the proportion of students who are anxious, less confident, have difficulties in concentrating and who exhibit some disturbed behaviours is higher in disadvantaged schools compared to others.

4. **Reluctant participation:** disadvantaged and disaffected students have low attendance rates.

5. **Unpredictable school climate:** this means that teachers have to deal with various issues including unplanned events, disciplinary incidents, counselling children and require more time for paperwork and planning.

These studies highlight that improvement of schools will not be achieved by generic measures, but only by policies tailored to disadvantaged areas and sensitive to differences between these areas (Crenna-Jennings, 2018). There are other challenges faced by schools in disadvantaged areas identified by the CONNECT consortium too.

- **Low academic performance:** Schools in disadvantaged areas often struggle with low academic achievement, leading to lower educational outcomes for students.

- **Achievement gap:** There is a significant disparity in achievement levels between disadvantaged students and their more advantaged peers. This gap further widens the cycle of disadvantage.

- **Socio-economic disadvantage:** Students in disadvantaged areas often face socio-economic challenges, such as poverty, limited access to resources, and adverse living conditions, which can negatively impact their educational opportunities.

- **Limited resources:** Schools in disadvantaged areas may have limited funding, inadequate infrastructure, and a lack of educational resources, which hinders their ability to provide quality education.

- **Social inequality:** Disadvantaged areas often experience higher levels of social inequality, including issues related to discrimination, unequal opportunities, and limited access to support systems, all of which can affect students' educational experiences and outcomes.

These challenges hinder educational outcomes and contribute to the cycle of disadvantage. To address these challenges, targeted interventions are necessary, such as improving resources, providing teacher support, promoting community engagement, and implementing strategies to bridge the achievement gap and reduce socio-economic disparities.

The CONNECT project's evaluation approach placed emphasis on supporting open schooling planning, implementation, and assessment with a particular focus on refinement, and evidence-based impact. Recognizing the importance of sustained transformation, the CONNECT consortium argues that obtaining substantial evidence at scale, supported by mixed methods approaches, is crucial for policymakers, including science department coordinators, school heads, and local and national authorities.

Mixed methods studies are highly important in providing evidence to government decision makers. These studies combine qualitative and quantitative research approaches, allowing for a more comprehensive and nuanced understanding of complex social issues. By incorporating a diverse range of data sources and employing various research methods, mixed methods studies play a pivotal role in establishing a solid foundation of evidence to inform policy decisions (Chesnut et.al., 2018). This comprehensive approach not only contributes significantly to the scientific research community but also holds substantial value for research-based practitioners. The integration of multiple data sources and research methods enhances the reliability and credibility of findings, ultimately strengthening their applicability in shaping effective policies.

Qualitative methods, such as interviews, focus groups, and observations in CONNECT, allowed partners to explore in-depth perspectives, experiences, and contexts. Quantitative methods through the CONNECT-science instruments, on the other hand, provided numerical data and statistical analysis, offering generalizability and patterns across a larger population. By combining these approaches, mixed methods studies can provide a more complete picture of the issue at hand, capturing both the depth of individual experiences and the broader trends and patterns within a population.

For practitioners and educators unaware of the open schooling approach, having access to evidence from mixed-method studies is crucial. It allows them to make informed decisions, considering the diverse perspectives of those involved including students, context-specific factors, and quantitative data on the potential impact of proposed policies. Robust results with evidence based on mixed methods help policymakers understand the complexities and nuances associated with social issues, leading to more effective and targeted policy interventions.

Overall, in the context of CONNECT, our mixed-method studies play a vital role in providing all stakeholders with rich, contextually grounded evidence supported by qualitative and quantitative data, facilitating more informed and evidence-based policy decisions. Our findings presented in this book refers to the current phase of the project “developing transformation” (1st of Nov 2021 to 1st of June 2023) – a month before the CICOS2023 - CONNECT international Conference on Open Schooling 2023. The just-in-time updated report with quantitative findings and our website with qualitative best practices which will continue been expanded can be accessed by anyone through the QR-Code as follows.

“My daughter’s participation in the CONNECT program has strengthened her confidence in identifying, analysing and dealing with everyday life problems. It also helped the rest of the family to change their perspective on this particular issue.”
Greek Parent - 2023

“Through the implementation of the CONNECT program, we were given the opportunity as a family to deal with the gorges of Crete, looking for information and photos that really impressed us, but also to go hiking with our teachers and our children.”
Greek Parent 2023

“The CONNECT program pushed us, at home, to take action to protect the environment with changes in our daily lives. “I was surprised at how the school collaborated with the town hall and organised a campaign about recyclable and biodegradable plastics. Our community is small, and such actions have a huge impact.”
Romanian Parent 2023

“I will never forget my child’s enthusiasm after every excursion that took place within the framework of the specific program, but also his insistence that we also visit the specific places. Well done to all of you! Waiting for more similar actions...”
Greek Parent 2023

Students' Transformation: empowerment!

This chapter presents the case studies in Europe and in Brazil to illustrate the transformative impact of open schooling and its profound impact on students’’ connection with science in their lives.

Lower secondary students as INDEPENDENT SCIENTIFIC-THINKERS

This UK case study focused on environmental protection and involved lower secondary school students (ages 11-14) who participated in a structured scenario called Rewilding. This open schooling initiative aimed to address biodiversity issues influenced by human behaviour and climate change. The students engaged in discussions with their families and scientists to deliberate on the potential reintroduction of species such as wolves and lynxes to their natural habitats. The key change with open schooling noticed by teachers was a different approach to fostering students’ scientific thinking, which involved the application of science, mathematics, and geography to develop solutions to a problem. The students created presentations using evidence from various sources to support their choice of animal for rewilding. They also evaluated the pros and cons of their decisions and interpreted collected data using graphs. Throughout the process, they practised essential skills like formulating questions and communicating visually using their science, maths, geographic knowledge about habitat studies with evidence-based thinking. This all helps to prepare them as independent citizen-thinkers. A life-changing transformation.

> *“I discussed evidence, the food web, ecosystems, and I learned how to create arguments. I enjoyed making my decision, creating a map, a food web, and a poster for a campaign. I learned how to work collaboratively to produce our work. I learned how to use arguments and check sources with the scientist; with my family I discussed opinions and facts. I would like to be a forest engineer, environmental journalist, or an ecologist. The rewilding activity was cool”.*
>
> *Student, female, 13 years old from the UK.*

Secondary students as ENERGY-Efficiency MARKETING SPECIALISTS

In this UK case study, lower secondary school students (ages 12-14) participated in Energy Savers, an open learning scenario focused on assisting an entrepreneur to invent a home energy-saving device. Through discussions with their families and scientists, students gained insights into energy transfers and efficiency. Notably, teachers observed a shift in promoting students' skills by integrating science, maths, and marketing (beyond the curriculum). As part of the project, the students created a funding page for a "solar panel cap for charging mobile devices" to raise funds for production. This outcome reflects the practical application of theoretical knowledge and analytical thinking in the context of the green economy. The project not only reinforces concepts learned but also demonstrates the efficacy of scientific knowledge in tackling contemporary challenges supported by scientists and families. However, it was noticed that some children do not have the same support from parents as others. The change was providing all the opportunity to interact with a science professional. Ultimately, this experience helped cultivate the students' entrepreneurial mindset and their understanding of the value of science in shaping their future professions, leading to transformative outcomes. A future-changing transformation.

> *"I Discovered different ways we can get energy. (Example: Tidal) I did A poster about solar caps. I did not find it difficult. Not really, except for when we started the subject when I wasn't too sure about the topic. With the scientist, I have learnt ways we could save the environment in different new ways. About my family (Sadly I cannot remember the last thing they taught me.) I think I'd like to be an Archaeologist?"*
>
> *Student, male, 13 years old from the UK*

Lower secondary students as SCIENCE-HEALTH COMMUNICATORS

This Catalunya case study focussed on Health. Secondary school students (ages 13-14) investigated a socio-scientific issue related to improving the prevention of pandemic diseases such as Covid-19 at their school. The students chose to create, design, and edit videos as a means of disseminating their research findings. This open scenario provided opportunities for collaborative learning within the classroom and with other stakeholders. Teachers highlighted a key change in the students' ability to use communication skills in real-world settings. The students became more confident in engaging and arguing in debates and presenting their own opinions to the group, as well as to various stakeholders during assemblies. They were able to stand by themselves. An empowering transformation.

> *"It was interesting to see how the students gradually engaged during the activities, especially the debates. At first, there was some reluctance to participate in the discussions, perhaps for fear of not having their position respected or valued. When they realised that their contributions were accepted and taken into account, more and more students decided to present their positions. The students were very interested in the topics under discussion".*
>
> *Open schooling teacher from Catalunya*

Secondary Students as GREEN DIGITAL RESEARCHERS

This Romania case study involved upper secondary school students (14-16) who had their classroom transformed into a creative learning environment, where they learned new ways of solving problems, and reporting their findings. Students completed their science actions in various scenarios including Biodegradable Plastic and Rewilding. They developed a science action and decided issues by researching information and using various ICT tools to document, present their ideas and promote awareness. The key change indicated by teachers refers to the students' improved use of scientific and digital skills and innovations in use of digital tools for communicating ideas which is key for preparing students for the green digital transition to innovation. Romanian students used different platforms (PREZI, ANIMOTO; MIND MAP) to document their findings and present different case studies in a very engaging way to their different audiences. Romanian teachers rethought the classic lesson by making them more interactive. A substantial Transformation.

> *"Science and technology are part of our lives and using them in a way that adds value is important. Even though at first students wondered "Can I do this?" "Will I be able to do it well?" "How can I do it better? ", the freedom to experiment, the accessibility of the platform, the ease of use and their engagement led to positive feedback."*
>
> *open schooling teacher from Romania.*

Upper secondary girls as GREEN DIGITAL ENTREPRENEURS

In Greece, this case study refers to girls' secondary school students (15-17 years old) who worked in an open setting based on controlling the spread of infectious diseases. The project began by asking students to identify concerns and needs related to the problem. They then investigated the challenges and priorities to come up with possible solutions. The change reported by the teachers focused on the student's agency empowered by skills that were evidenced by the project outcomes e.g. Students designed and built sensors to measure airborne particles. Students established links with scientists and policy makers in Greece. In particular, it was observed that the change became more evident with this contact that did not exist before that helped students see how scientists approach global and local problems. A remarkable transformation.

> *"At first, we discussed our subject in the classroom, then we raised our concerns and then we had discussions with many experts on the subject who helped us to understand the subject to a greater extent and find ways to deal with it. I learned even better about the concept of cooperation and teamwork through the project that we all did together with classmates and teachers. Important things that will benefit me and after my life. That we can sit and discuss not only about things in everyday life but also about more specialised topics that will be even more interesting."*
>
> *Student, female, 17 years old from Greece.*

Primary pupils as ENVIRONMENT-PROTECTION POLICY-MAKER

In Mariporã, São Paulo, Brazil, primary school pupils (aged 5-6; 10-11) undertook a project to protect wild animals in the world's largest urban forest. They wrote a letter to the local council requesting the inclusion of signs for car drivers near the park to raise awareness and promote animal safety. This project led to a significant change in research-based policy. The students engaged in various scientific activities, including observing animals in the forest and zoo, analysing, and comparing animal data sheets, discussing key concepts, and developing communication skills such as oral, visual, and written competencies. These activities resulted in a policy change aimed at protecting the forest's animals. This project was an unforgettable experience that allowed the students to actively participate in conservation efforts and make a positive impact on their local environment. An unforgettable research-based policy transformation.

> *"Science is not just about doing experiments in the lab; it helps us think about how to help the world"; "I learned about the characteristics of forest animals, types of habitats and how to protect them; "Deforestation is increasing, and we need to do something."*
> *Pupil, female, 9 years old from Brazil.*

Primary students as GREEN CITIES ACTIVISTS

In Ponta Grossa - Brazil, primary students (7-11) were exploring green areas in a park but identified an issue themselves: the lake was murky and had an unpleasant smell. This spurred the students to wonder about why this might be and motivated them to research ways of cleaning up the lake, leading to an open scenario guided by the student's questions. Teachers experienced how open schooling allowed learning to be led by student's interests and the importance of students' own questions. Students were empowered by seeing that they could use their science knowledge to raise questions related to their environment. Their questions were not told by teachers; these were their own choices related to what they care about. They were intrinsically committed to find solutions and this effect in change. A meaningful teaching-learning transformation.

"I learned that science is something interesting and good to study. I liked the trip to Lago de Olarias, I learned more about water and its mixture with other substances with scientists. I learned that bacteria can be both good and bad with my family."
Pupil, female, 10 years old from Brazil private school, parents work with science.

"I learned to ASK MORE. With the scientists I learned that science is something interesting and good to study, with the family we learned that it is important to take care of the Environment."
Student, male, 11 years old; private school, parents don't work in science.

"After three weeks, I observed that students became more self-confident in the process, with me as their 'researcher,' and with our shared purpose. For instance, one student mentioned the challenging experiences they had with their family and the prevalence of local crimes. They also highlighted the difficulty of playing or being near the polluted and dirty river, as well as the lack of good recreational spaces near the school. As a teacher and PhD student researcher, these observations were notable."
Teacher-PhD student researcher.

School & university students as AR-SCIENCE-TECHNOLOGY PARTNERS

In Santa Catarina – Brazil, secondary students aged 14-16 and undergraduates in medicine, computer science along with natural sciences teachers partnered to explore AR resources. They used The Human Body open access resource developed by the OU-BBC to reflect innovative solutions to make science learning more interactive, immersive, and meaningful with real-life issues. This included not only science content but deep understanding of science concepts with emerging technologies. The key change was the strong connection to science through the deep fun of students with undergraduates exploring AR, talking about science issues, and using AR at home to discuss the issues with parents and community members. Experience of using AR provided confidence for students to use AR and develop their own AR resources. Undergraduates supported AR in school with all resources developed inhouse and supported by the Brazil government. A big science-technology enhanced learning transformation.

> *"Parents found that kids were very excited, and AR created more opportunity for them to show and discuss the content with them. Undergraduate students enjoyed interacting with the school community and realised that they could develop more AR resources in other topics and areas."*
>
> *Computer Scientist Researcher leading university-school partnership for open schooling. Computer Scientist leader of Open Schooling University-Schools partnership*

Secondary students as WOMEN-WELLBEING RIGHTS ADVOCATORS

In Ceara – **Northeast of** Brazil two initiatives integrated with open schooling by researchers who explored the empowerment of girls (15-17) to ensure health and physical safety in the municipality of Monsenhor Tabosa as well as teachers' professional development with projects of intervention in the whole state. The first significant change was reported by teenagers who felt capable to voice their concerns, raise questions and based on the responses of science professionals. They felt more confident to talk about sensitive issues using science and increased their awareness of their local communities about teenage pregnancy, mental and physical violence.

In parallel the secretary of education of Ceara delivered a large-scale professional development for more than 10,000 teachers to enhance quality of education in conjunction with their pedagogy about projects of intervention. These have some similarities which resulted in an adapted approach of students intervening in their communities to solve real-life problems underpinned by curriculum knowledge, citizens, and experts. This initiative was very relevant for tackling gender violence with science and digital inclusion and teachers' professional development. A significant Transformation.

> *"The first word that comes to my mind when I hear science is research, and the first problem for science to solve is poverty. Science is very important for our lives. I found this survey quite interesting and peculiar. The whole process was rewarding, special, and enjoyable.*
> *Doing this work opened my eyes to how research is important for my life, not just for school assignments."*
> *Student Girl 17 years old Brazil Ceará.*

Upper secondary students: NATURE-BASED SOLUTIONS ENTREPRENEURS

In Camaçari - Brazil, upper secondary students (aged 17-19) carried out an open scenario based around sustainability. Students were encouraged to come up with their own ideas for responsible waste disposal. They then settled on looking into the production of bioplastic using cassava waste. This work focused on how the students can make a positive impact on society, economy, and environment. Teachers noted that the project empowered students with knowledge, skills, attitudes, and values that enabled them to transform their lives, the way they can work together and also becoming effective leaders for transforming people's lives with agro-eco-industry/ green-economy, environment. As cited by a student "Scientific knowledge is power when it comes to solving social problems". It is an impactful transformation.

"I learned from my family the importance of engaging more with science to assist people in basic matters. I also learned the foundations and principles of how science is vital in our lives and realised the need to improve our understanding of it. Through interactions with scientists, I discovered that unfortunately, science is not widely recognized or promoted in our region."
Student 18 male Bahia Brazil

"I believe that if we could raise more awareness, more people would pursue careers in this field, as it holds significant value for our brains and minds, opening our eyes to the world. Scientific knowledge is power when it comes to solving social problems."
Student 17 female Bahia Brazil

"One of the most enjoyable aspects for me was understanding the step-by-step process, from initiation to production, and learning how to guide team members effectively and fulfil the role of a leader. I learned how the sustainable world functions and how to transform knowledge into accomplishments, conducting meetings to move knowledge forward and transform other lives."
17 female Bahia Brazil

Upper secondary students: Green Economy Engineers

In Irecê, Brazil, students in upper secondary school (aged 16-18) undertook a project focused on achieving Carbon Neutrality by exploring new sources of green energy and innovative methods of producing renewable energy for the rural areas of Bahia. Through this project, the students developed an awareness of the importance of utilising science and recycling materials to collaboratively create models aimed at reducing carbon emissions through clean energy. They discovered that complex and abstract concepts can be learned in a rewarding manner. The recognition they received in the science olympic games, where they were awarded 21 medals, was particularly impressive for the young generation, who often face limited access to technology, low internet connectivity, and lack of interaction with their families. The acknowledgment from academia, businesses, policymakers, and awards committees made a significant difference in their lives, leading to a transformative experience. A powerful transformation.

"Personally, I found this project to be an incredible learning opportunity. I thoroughly enjoyed the process of working on it, which involved generating energy using conductive materials. It was an enjoyable and engaging experience. I had the chance to explore a wide range of fascinating topics, including understanding the functionality of conductive materials in generating electricity and discovering the applications of fullerene. Additionally, I had the opportunity to delve into the diverse biodiversity of the Brazilian fauna and flora, among other captivating subjects. However, I must admit that it did not bring me as close to my family as I had hoped."

Community and Learners as LIFE RIGHTS ADVOCATORS IN AMAZON

This study occurred in the UK and Brazil: About Protecting Life in Amazon Refers to two different practices based on participants' CARE-KNOW-DO developed by the same researcher in Brazil and the UK. The first practice focuses on the partnership of community and professionals to bring real-life problems to be discussed in the school. The transformation of this innovative practice sought to go beyond mere knowledge transmission, involving community members in problem identification and co-creation of solutions collaboratively.

The second practice challenged the UK students to explore and find their own interests about rainforests using digital platforms Google, AI-chat GPT and the community in person and online. Students found information about various issues in the Amazon that they cared about. The key transformation was to develop critical thinking using browsers and AI, examining quality of information, investigating sources, devising questions, selecting references and assessing reliability of content to tackle problems which moved from the forest deforestation and to the preservation of the Yanomami indigenous peoples. A critical open thinking with open schooling transformation.

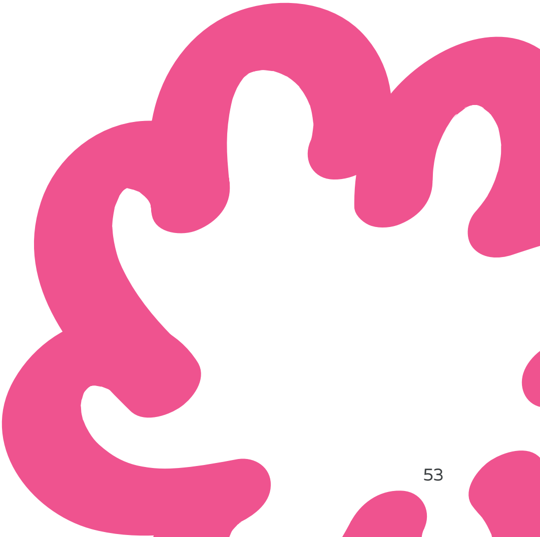
> *"What happened to the Yanomamis? This is a real issue that matters to us. We finished our poster without knowing the answer yet, but I've learned a lot about searching using Google, Siri, and OpenAI. Technology can be helpful, but sometimes it's not. What we learned as a group is that it's important not only to check different sources but also to use different technologies, explore different languages, and talk to various people. We shouldn't rely solely on one source."*

"I learned from scientists that science can be enjoyable and fun. Being able to work in groups and find data ourselves."
Students' 14 years old female UK

"My family find it fun learning new things about science and also using science to make decisions with me."
Students' 13 years old female UK

"With my family I learned that to do science correctly, you will need help from someone older."
17 female Bahia Brazil

"With my parents and grandparents, we get to research, we did experiments, we organised a survey and communication."
9 years old, São Paulo Brazil



Reflecting on the CONNECT's transformations

Open schooling has brought about transformative changes in education, empowering students, and fostering a more "collaborative teaching-learning"-centric approach including learners, educators, and communities (Figure 3).
Our case studies demonstrate the impact of open schooling on various aspects, including teaching methods, students' beliefs, confidence and attitudes towards science, and engagement with the local community. However, a key factor for students to feel more connected to science was moving from surface knowledge to deep and transferable knowledge. Empowering means fostering students who CARE-KNOW-DO science -actions for transforming lives and the planet (Freire, 1967).

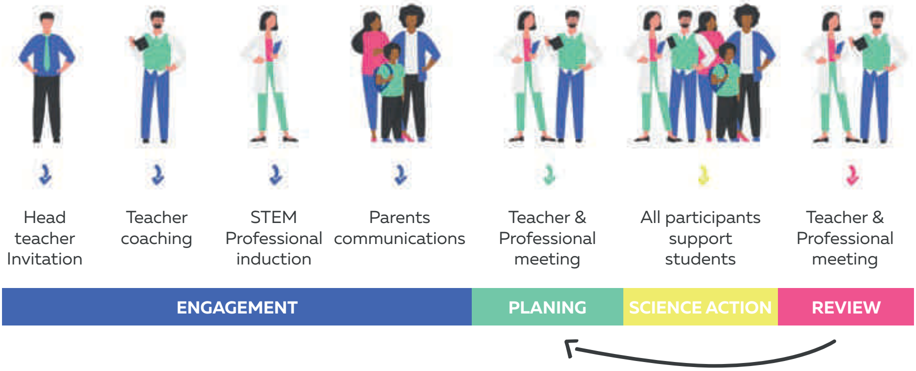

Head teacher Invitation
Teacher coaching
STEM Professional induction
Parents communications
Teacher & Professional meeting
All participants support students
Teacher & Professional meeting
ENGAGEMENT
PLANING
SCIENCE ACTION
REVIEW

Figure 3: CONNECT multi-actors to solve real-life problems.

Empowerment in education goes beyond simply imparting information to students' (Freire, 1996; 1984; 2009; Freire & Macedo, 2005; Hodson , 2011). It involves fostering a sense of ownership and agency in their learning process. When students are empowered with science, they become active participants in their education, taking on roles as investigators, critical thinkers, knowledge co-creators and problem solvers. These roles also include independent scientific-thinkers, science-health communicators, green digital researchers and entrepreneurs, environment-protection policymakers, green cities activists, technology and science partners, women-wellbeing rights advocators, nature-based solutions entrepreneurs, life rights advocators of minority vulnerable groups, among others.

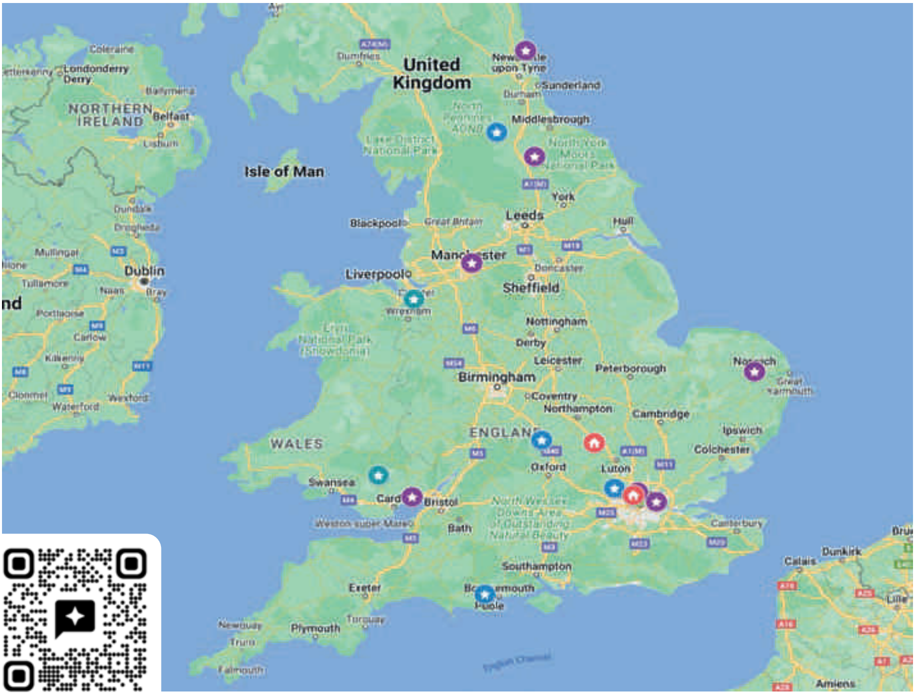
In terms of teaching, open schooling has revolutionised the classroom by enabling teachers to design lessons that depart from traditional didactic approaches. Through open schooling, educators have been empowered to explore innovative teaching methods that prioritise student participation and engagement, resulting in heightened motivation and enthusiasm for learning.
By shifting to a colearners-centric approach, teachers have created an environment where students actively contribute to their own learning supported by scientists, families, and community members. This approach fosters meaningful interactions not only with teachers but also with non-formal educators, experts, and members of the informal education community. These interactions expose students to a diverse range of perspectives, expertise, and real-life experiences, preparing them for their roles as lifelong learners and future professionals. Through open schooling, teachers have embraced co-creation of knowledge, recognizing that students possess unique insights, talents, and interests that can enrich the learning process. By valuing student input and encouraging collaboration, teachers have facilitated a deeper understanding of subject matter and nurtured critical thinking skills. Students are actively involved in constructing their own knowledge, connecting classroom learning with real-world applications, and engaging with authentic problems and challenges.

Open schooling has facilitated a seamless integration of various educational resources and technologies, providing students with access to a wealth of information and interactive learning experiences. By leveraging digital tools and online platforms, teachers can offer personalised learning opportunities, cater to diverse learning styles, and support students in acquiring essential 21st-century skills such as digital literacy, communication, and collaboration.

In summary, open schooling has transformed teaching practices by empowering teachers to design student-centred lessons that foster active participation, collaboration, and the co-creation of knowledge. Through meaningful interactions with various stakeholders, including experts and community members, students are equipped with the skills, knowledge, and mindset necessary to thrive as lifelong learners and professionals in an ever-evolving world. Open schooling also provides the competences needed to transform lives in the right direction towards sustainability.

Case 1. UK Science Actions driven by Youth

SDG 15 – Life on Land, Secondary school, 13-14


United Kingdom
NORTHERN IRELAND
Isle of Man
WALES
ENGLAND
Coleraine
Londonderry Derry
Ballymena
Belfast
Lisburn
Dundalk
Drogheda
Mullingar
Dublin
Tullamore
Naas
Bray
Portlaoise
Carlow
Kilkenny
Clonmel
Wexford
Waterford
Dumfries
Newcastle upon Tyne
Sunderland
Durham
Middlesbrough
North York Moors National Park
Lake District National Park
York
Leeds
Hull
Blackpool
Manchester
Liverpool
Doncaster
Sheffield
Wrexham
Nottingham
Derby
Leicester
Peterborough
Norwich
Great Yarmouth
Birmingham
Coventry
Northampton
Cambridge
Ipswich
Colchester
Oxford
Luton
Swansea
Cardiff
Bristol
Bath
Weston-super-Mare
Southampton
Canterbury
Exeter
Bournemouth
Poole
Torquay
Plymouth
Newquay
Truro
Falmouth
Calais
Dunkirk
Lille
Amiens

Map 2: CONNECT network of open schooling research schools in the UK.

TOWN CLOSE HOUSE

Photo UK 1: Students discussing about energy with an expert.

1.1 Low secondary students as INDEPENDENT SCIENTIFIC THINKERS using evidence from a range of sources to make claim

Authors: secondary school students of Town Close and
Nick Chapman, Jude Sanders; Tony Sherborne.

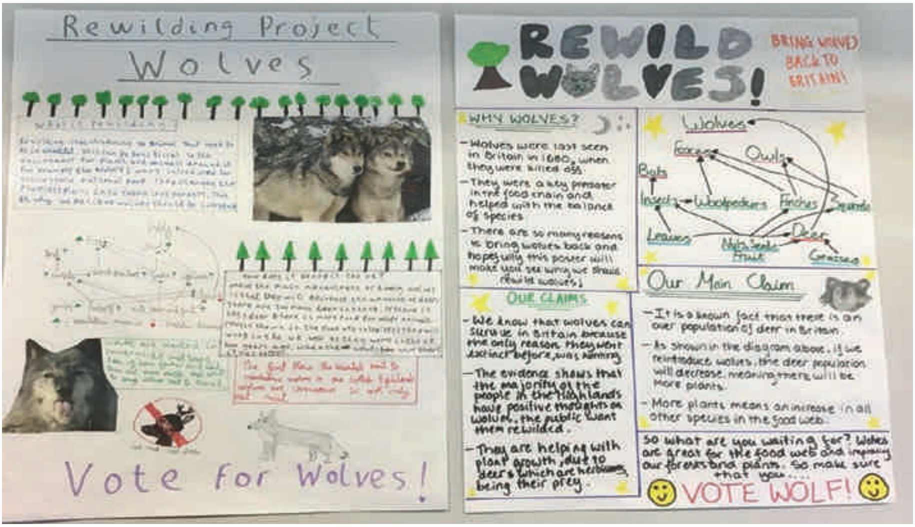

Rewilding Project
Wolves
Vote for Wolves!
REWILD WOLVES!
BRING WOLVES BACK TO BRITAIN!
WHY WOLVES?
OUR CLAIMS
Wolves
Foxes
Owls
Bats
Insects
Woodpeckers
Finches
Squirrels
Leaves
Nuts, Seeds, Fruit
Deer
Grasses
Our Main Claim
VOTE WOLF!

Photo UK 2: Students' rewilding posters for a campaign.

This study examines the implementation and results of a 'Rewilding UK' initiative undertaken at The Thomas Lord Audley School in Colchester, Essex, and Town Close School, Norwich. This innovative open schooling activity was orchestrated with the assistance of the Mastery Science team, two Open University researchers, and a science educator based in the UK. Participating classes, encompassing a total of 330 students', formulated and executed a science action project on rewilding, encouraging family discussion and public persuasion about the merits of the practice.

CARE:	The theme of rewilding was chosen as an engaging and thought-provoking challenge, prompting students to explore strategies for environmental protection via the reintroduction of extinct species into their native ecosystems. Students responded enthusiastically to the materials provided, particularly the educational videos, showing a keen interest in addressing biodiversity issues influenced by human behaviour and climate change.
KNOW:	Students displayed critical thinking skills in evaluating the pros and cons of their decisions, utilising theory in their decision-making processes. They interpreted collected data about reintroduction species and demonstrated an enhanced understanding of how small-scale actions can have extensive implications (e.g. biodiversity and ecosystem balance). They expanded their knowledge of ecosystems, food webs, and interdependence and practised skills such as question formulation, data analysis, visual communication and, evidence evaluation to substantiate a claim. They also employed mathematical skills in graph creation and geographic knowledge in habitat study.
DO:	Students deliberated on the potential reintroduction of species such as beavers, wolves, and lynxes to UK habitats, using a voting system to gather wider opinion. The rewilding project was met with universal enthusiasm from the students, fostering their curiosity and decision-making abilities. Their confidence in applying scientific knowledge was also noted, demonstrating respectful disagreement and discussion without personal affront. However, it's worth noting that for some students, evidence of family involvement was missing for half the class for various reasons. Scientists evaluated the best group presentations.

RESULTS: This open schooling project proved beneficial for promoting student engagement and meaningful learning. Students showed satisfaction with their research, analysis, and presentation tasks. However, some lower-ability students struggled with distinguishing a scientific question from a claim, suggesting the need for additional support in data analysis. Differentiation for lower-ability students was another challenge. Teachers felt that the initiative successfully enhanced students' interest and confidence in science, with students acknowledging the relevance of science in their daily lives and expressing enjoyment in learning. The data also indicated that nearly half of the students lacked confidence in their scientific knowledge. While some students demonstrated confidence in presenting claims supported by evidence, others required further assistance. Another problem to be noted is that only 30 students were able to answer the form online at home. Despite challenges with time constraints and knowledge development, the activity fitted well into the curriculum. The children enjoyed it and wanted to know if it 'was real'. I think some thought that their votes would genuinely count towards initiated a rewilding of their animal.

1.2 Secondary students as ENERGY EFFICIENCY MARKETING SPECIALIST to promote energy saving devices

Authors: secondary school students of Town Close and
Nick Chapman, Gemma Young; Alexandra Okada.

Photo UK 3: Renewable energy engineer supporting students.

The objective of this initiative led by the same school who adopted open schooling was to educate students about the importance of energy-saving choices when purchasing devices. During the initiative, 60 students participated in a science action program called "Energy Savers." The students were actively involved in the activity, and although they expressed a desire for more time, they found it engaging and it sparked their curiosity.

CARE: At school, students were introduced to the task: to help an entrepreneur to choose an idea for an energy saving device. They discussed why we need to save energy and heard from a local engineer who talked about how his work was helping to develop new renewable energy technology.

At home, the students discussed with their families which of the inventions they think should be built, based on if they thought it was useful and if it could save energy. They voted online for their top three favourites.

KNOW: In this stage, to prepare students for the task they learnt about energy efficiency by measuring the efficiency of a range of energy devices.

DO: In the “DO” stage, students were assigned two tasks. The first task required them to calculate the efficiency of three different solar panels. The second task involved designing a fundraising page for an energy-saving device, including a description of how it works as well as convince customers why they should buy it. The students worked in teams and presented their marketing ideas to the rest of the class.

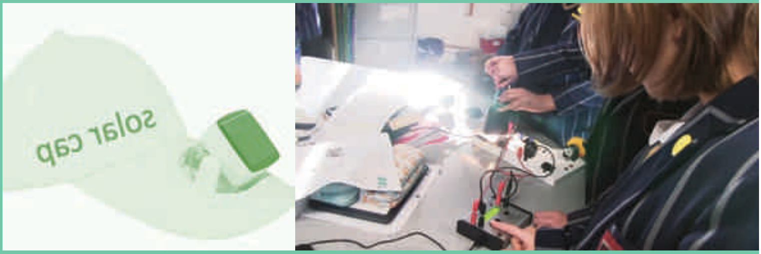
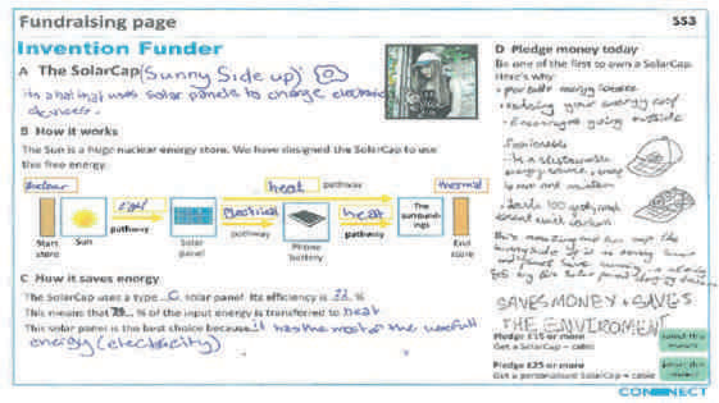


Photo UK 4: Students science-actions to consolidate conceptual understanding.

RESULTS: The findings of the initiative indicated that it effectively supported students’ learning and aligned well with the curriculum, specifically in the areas of energy transfers and wasted energy. The activity had a positive impact on the students’ confidence in science; it encouraged meaningful discussions among students and facilitated the development of research skills. To further enhance student outcomes, they can be encouraged to design their own energy-saving devices, promoting creativity and deeper engagement with the subject matter.



Fundraising page 553

Invention Funder

A The SolarCap (Sunny Side up)

It's a hat that uses solar panels to charge electronic devices.

B How it works

The Sun is a huge nuclear energy store. We have designed the SolarCap to use this free energy.

nuclear
Start store
Sun
light
pathway
Solar panel
electrical
pathway
Phone battery
heat
pathway
heat
pathway
The surroundings
thermal
End store

C How it saves energy

The SolarCap uses a type C solar panel. Its efficiency is 21 %

This means that 79 % of the input energy is transferred to heat

This solar panel is the best choice because it has the most of the useful energy (electricity)

D Pledge money today

Be one of the first to own a SolarCap. Here's why:

- portable energy source
- reducing your energy cost
- Encouraging going outside

Fashionable

SAVES MONEY + SAVES THE ENVIROMENT

Pledge £15 or more
Get a SolarCap – cable

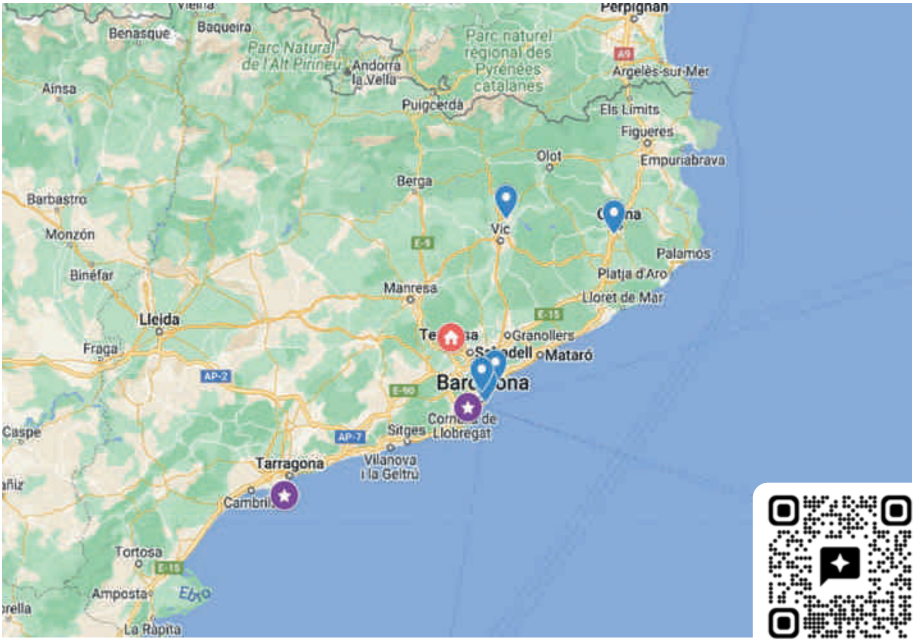
Pledge £25 or more
Get a personalised SolarCap + cable

CONNECT

Photo UK 5: Students science-actions bringing theory to practice with purpose to for engaging communities and promote knowledge exchange.

Case 2. Spain Science Actions driven by Youth

SDG 3 – GOOD HEALTH AND WELLBEING, Secondary school, 13-14


Perpignan
Benasque
Baqueira
Parc Natural de l'Alt Pirineu
Andorra la Vella
Parc naturel régional des Pyrénées catalanes
Argelès-sur-Mer
Aínsa
Puigcerdà
Els Límits
Figueres
Olot
Empuriabrava
Berga
Barbastro
Vic
Monzón
Palamos
Binéfar
Platja d'Aro
Manresa
Lloret de Mar
Lleida
Granollers
Fraga
Mataró
Barcelona
Caspe
Cornellà de Llobregat
Sitges
Tarragona
Vilanova i la Geltrú
Cambrils
Tortosa
Amposta
Ebro
La Ràpita

Map 3: CONNECT network of open schooling research schools in Spain.

Photo Spain 1: Students science-actions in Catalunya.

2.1 Low Secondary students as HEALTH COMMUNICATORS: prevention of COVID 19 supported by participatory research.

Authors: secondary school students of Escoles Sentinella and Montse Masdeu, Roser Alcaraz, Rosina Malagrida.

This good practice reports an open schooling activity featuring an open scenario conducted during the pandemic period by the teachers Montse Masdeu and Roser Alcaraz. The activity took place with the participation of 44 teachers and 868 students and their parents from six Spanish schools during 2021. One of the schools was the Institut Antoni Pous i Argila (Manlleu, Barcelona, Spain) involving 60 students aged 13-14.

CARE: The socio-scientific issue addressed in this activity was how to enhance Covid-19 prevention at school. The professionals that gave support were the scientific community from Escoles Sentinella project: science communicators, biologists, epidemiologists, paediatricians among others. Through an invitation letter to the project and with preliminary knowledge exploration with students and families, they became fully engaged.

KNOW: A participatory research was conducted to explore the main problems, needs and opportunities to improve Covid-19 prevention. The exploration was performed following a methodology called System-Oriented Dialogue Model, where students learned about the complexity of the challenge and the interconnections between factors in different areas of the system. As the activities were implemented from the tutoring sessions, the students also developed debate and citizenship education competencies (e.g. related with social value) and they learned about how the coronavirus is spread and why we need those prevention measures to protect everybody from the transmission.

DO: The students developed communication skills and skills to create, design and edit video, as they chose to disseminate their results through a video.

Students also developed inquiry skills, participation skills and transdisciplinary methodologies. The science actions included teamwork, collaborative learning within the class and with other stakeholders and learning how science is useful for solving real-life challenges.

RESULTS: The implemented activity was aligned with the curriculum of Obligatory Secondary Education (ESO). Students gained confidence in debating and presenting their own opinions to the group. The activity has led to greater awareness of Covid-19 prevention and how the measures to achieve that can be improved by a participatory and system-oriented research process. The results were published in a scientific paper.

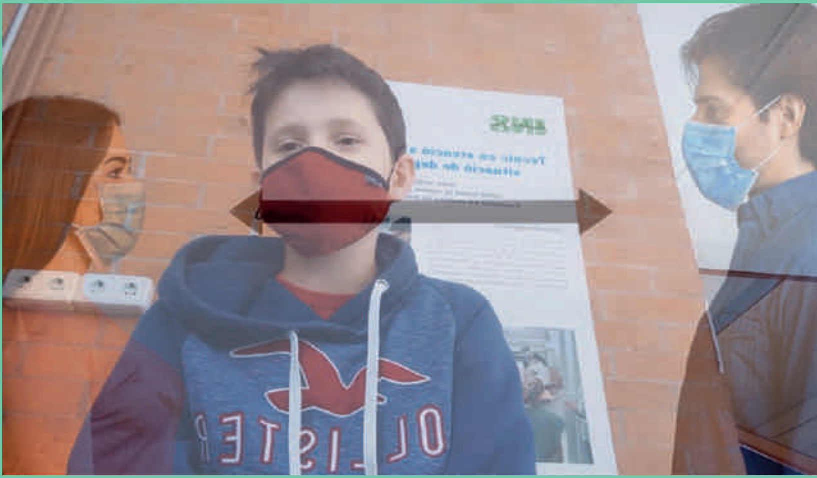


Photo Spain 2: Students science-actions in Catalunya.

2.2 Secondary students as MENTAL HEALTH ADVOCATORS: emotional well-being with Healthy habits and lifestyle.

Authors: secondary school students in Granada, Juan XXIII Chana, Victor Molinero, Rosina Malagrida and Laia Vives.

This significant initiative discusses the urgent need to prioritize mental health promotion in schools, citing data from various studies that highlight the increasing prevalence of mental health disorders among young people. It also emphasizes the disconnection between academia and society, leading to skepticism regarding the practical application of scientific knowledge to address societal issues, particularly among students (Abma et. al, 2010).

To address these challenges, the Guidance Department of CDP Juan XXIII Chana in Granada has implemented an educational project called "Healthy Minds" as part of their Tutorial Action Plan supported by IRSICaixa. The project adopts an Open Schooling approach, empowering students to become active agents in promoting mental health. The initiative is carried out within the framework of the European project CONNECT. The Healthy Minds project has involved six class groups from the 1st and 3rd years of Secondary Education, comprising 180 students and their families. The students have actively participated in sessions designed by Healthy Minds and have implemented an action plan to address identified mental health needs.

CARE: Firstly, the concept of health, as defined by the World Health Organization (WHO), was explored. Students discovered that health encompasses not only physical well-being but also social and mental aspects, with emotional well-being being a common factor.

KNOW: Secondly, students identified risk and protective factors for mental health, prioritizing those deemed most significant. They proposed creating an “Emotional Kit” as a solution, which consists of tools to protect themselves in risky situations and promote emotional well-being.

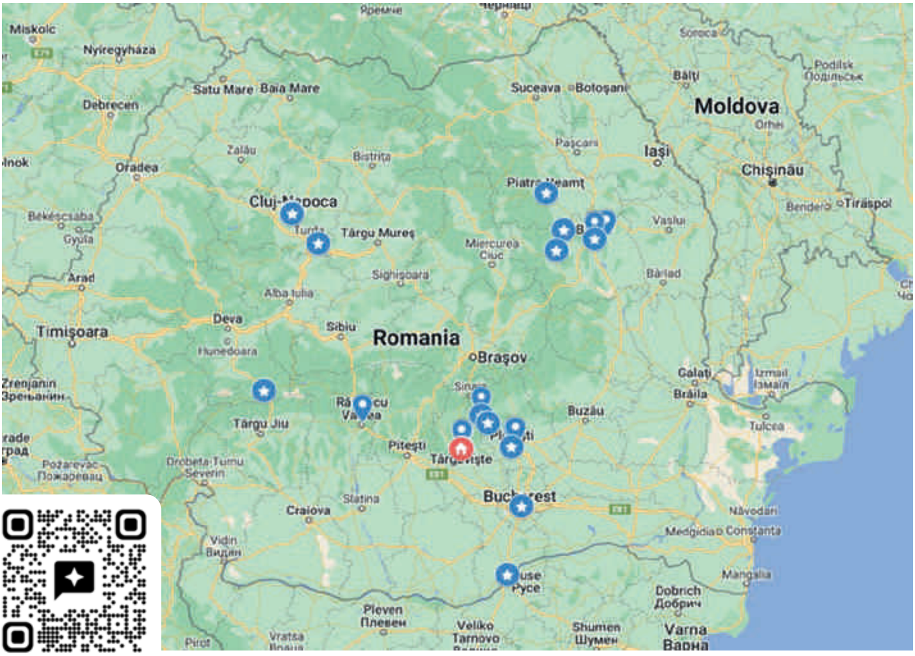
DO: Lastly, students reflected on the learning process and the impact of mental health promotion. Throughout the project, teachers and families actively participated, fostering collaboration in designing solutions. The Healthy Minds project has yielded several positive outcomes within the educational community.

RESULTS: Notably, students have developed a heightened awareness of the importance of mental health and their ability to contribute to its improvement through participatory research. The project has also encouraged self-organization among students, and the school institution has shown increased commitment to mental health promotion. The school plans to create a physical space called the “Emotional Classroom” to support emotional well-being. Additionally, the Guidance Department will collaborate with the existing “Healthy habits and lifestyle” program to design interdisciplinary activities aimed at promoting student well-being.

Photo Spain 3: Students science-actions in Catalunya.

Case 3. Romania Science Actions driven by Youth

SDG 15 – Life on Land, Secondary school, 14-16


Miskolc
Nyíregyháza
Debrecen
Satu Mare
Baia Mare
Suceava
Botoșani
Moldova
Bălți
Soroca
Iași
Chișinău
Tiraspol
Zalău
Oradea
Bistrița
Pașcani
Piatra Neamț
Cluj-Napoca
Turda
Târgu Mureș
Miercurea Ciuc
Vaslui
Bârlad
Békéscsaba
Gyula
Arad
Sighișoara
Alba Iulia
Deva
Sibiu
Timișoara
Hunedoara
Romania
Brașov
Galați
Brăila
Izmail
Tulcea
Zrenjanin
Târgu Jiu
Râmnicu Vâlcea
Buzău
Pitești
Târgoviște
Ploiești
Drobeta-Turnu Severin
Slatina
Bucharest
Craiova
Năvodari
Medgidia
Constanța
Vidin
Ruse
Mangalia
Pleven
Dobrich
Veliko Tarnovo
Shumen
Varna
Vratsa
Pirot

Map 4: CONNECT network of open schooling research schools in Romania.

REINTRODUCEREA URSULUI IN ECOSISTEM
IUBIM URSII

Photos Romania 1: Students' science-actions of Romanian Schools.

3.1 Secondary Students as GREEN DIGITAL ECOLOGISTS: protecting our national park ecosystem with rewilding.

> Authors: Students of "Voievodul Mircea" High School în Targoviste, a group of teachers including Mrs. Nae Florentina Laura, Gabriel Gorghiu and Mihai Bizoi.

This initiative is about the structured scenario – Rewilding. A total of 35 students aged 14-16 years participated in the activities. Students improved their ICT skills, using different platforms (PREZI, ANIMOTO, MIND MAP) to document and present different case studies.

The activities allowed for a modern, cross-curricular approach, transforming the classroom into a creative learning environment, where pupils learned new ways of solving problems, acquired those skills targeted by the curriculum, created and used tools in an innovative way. The students presented their products in an activity in which three experts from Valahia University in Targoviste participated.

CARE:	The resources were very useful as they motivated the teacher to rethink the lesson and increase the students' input in their learning process. The STEM lesson becomes motivating not only for the teacher, but also for the students by developing students' ability to collaborate with others when tackling a problem and formulating solutions.
KNOW:	The activities allowed them to take a modern, transdisciplinary approach, thus transforming the classroom into a creative learning environment where students learnt new ways of solving problems, acquired those skills targeted by the curriculum, created, and used tools in an innovative way. Science and technology are part of our lives and using them in a way that adds value is important.

DO: The students were really engaged in the new activities proposed by the new type of lesson, and students were observed to show willingness to participate in a greater number of lessons designed using the new structure. The students felt attracted by the new learning/expression possibilities. The challenges and opportunities created by the COVID-19 pandemic, led to the unprecedented use of digital technology during this period. Even though at first students wondered “Can I do this?” “Will I be able to do it well?” “How can I do it better? “, the freedom to experiment, the accessibility of the platform, the ease of use and their engagement led to positive feedback.

RESULTS: Open educational resources were considered useful for designing a modern, interactive lesson, involving rethinking the classic lesson. The use of open schooling resources increased student motivation, adapting the instructional-educational approach in the manner of a modern, interactive lesson.

3.2 Secondary Students as GREEN DIGITAL ACTIVISTS for Biodegradable Plastics as a solution for White Pollution

Authors: secondary school students of Voievodul Mircea High School and Coșoveanu Francesca, Diaconescu Cristina, Dumitrescu Anca, Eftimie Cristina, Nae Florentina Laura, Oncioiu Diana, and lab technician Ursăchescu Eugenia, Gabriel Gorghiu and Mihai Bizoi.

This report presents an open schooling initiative on Biodegradable Plastics - a solution for White Pollution, developed at Voievodul Mircea High School in Târgoviște during the 2021-2022 school year. The initiative involved teachers Coșoveanu Francesca, Diaconescu Cristina, Dumitrescu Anca, Eftimie Cristina, Nae Florentina Laura, Oncioiu Diana, and lab technician Ursăchescu Eugenia. Professionals from the NGO "Mai Mult Verde" and the Environmental Protection Agency of Dâmbovița were also involved. The initiative received support from Valahia University of Târgoviște, Romania.

Photos Romania 2: Students' science-actions activity with an expert professional.

CARE: The students, aged between 15 and 18, actively engaged in scientific and educational activities focused on plastic pollution, which is a real-life problem with a significant impact on quality of life. Approximately 115 students from grades 9 to 11 participated in the initiative.

KNOW: The students applied their knowledge of plastics acquired in chemistry classes. This includes the biodegradation stages of plastic, chemical composition of plastic, stages of biodegradable plastic production, and research findings on the decomposition period of biodegradable plastic in nature.

DO: The students practised various skills, such as brainstorming debates, conducting individual or team projects, participating in volunteering and environmental cleanup activities, analysing statistical data on the use and decomposition of biodegradable materials, conducting awareness campaigns on the risks of White Pollution, and explaining packaging label symbols.

Photos Romania 3: Students' science-actions outside school.

In conclusion, the students prepared posters, thematic drawings, questionnaires, research projects, and conducted awareness campaigns. They worked individually and in teams, receiving support from their families and volunteers from the "Mai Mult Verde" Association, a non-governmental organisation.

RESULTS: The activities carried out during the CONNECT project were integrated into the curriculum. The provided materials were beneficial for preparing and implementing lessons with the students. The chosen topic for year 2 was relevant and innovative, generating global discussions in the scientific and educational communities. Consequently, the students had the opportunity to learn and personally experience ways to contribute to the prevention and mitigation of environmental pollution. Open schooling could be valuable for other teachers, as it allows for a focus on transdisciplinary experiences and the exchange of best practices among teachers who have implemented it in previous years and those who wish to join in.

The students enthusiastically participated in volunteering and environmental clean-up activities, gaining first-hand observations of biodegradation stages, and developing a deeper connection with nature. Their involvement contributed to environmental protection and improved quality of life. The students also enhanced their scientific research skills by actively participating in project creation and studying White Pollution, applying the knowledge gained from the provided materials. Students selected the most relevant photograph of their initiative and publicised under open licence on the website to represent the practice.

3.3 Secondary Students as CO2 NEUTRAL CONSULTANTS: supporting a café to reduce CO2 emission

Authors: secondary school students of Școala Gimnazială Mihai Viteazul, Pucioasa, Școala Gimnazială Vârfuri, Școala Gimnazială Runcu, Gabriel Gorghiu and Mihai Bizoi.

This initiative presents the work done by various schools in Romania involving a large number of students, teachers, local community cafes and academics from VUT who used the “Connect Science Action: Carbon Neutral” integrated into the secondary school curriculum, addressing carbon emissions, climate change, and global warming.

CARE: The activities engaged Students to watch a video and discusse the importance of influencing decision-makers to take action on climate change. The problem-solving aspect was introduced through a scenario for students to act as climate consultants and help a café company reduce its carbon footprint and achieve carbon neutrality. As part of the homework task, students discussed with their families’ carbon footprints and calculated their own using an online tool. They learn about making personal changes, such as the ones suggested in the activities, for example, reducing meat consumption, flying less, or using electric cars. Families then make pledges to reduce their carbon footprint, moving closer to carbon neutrality.

KNOW: In the first activity, teachers demonstrated how to identify sources of carbon emissions within an industry using fast fashion as an example. Students applied this knowledge to determine how the café emits carbon, considering aspects like goods transport and waste disposal. They learned a skill through a game and then apply it to identify the changes the café needs to make to become carbon neutral. They consider the potential changes identified in the previous activity, assessing their cost and effectiveness in reducing carbon emissions.

DO: At home, students and their families explored carbon offsetting. They examined different options for investing in companies that could offset their carbon footprint and discussed which option they would choose and why. Back at school, they worked in groups to plan their recommendations for the café, drawing on everything they've learned. They then presented these recommendations.

RESULTS: This comprehensive Science Action helped students connect scientific knowledge, practical application, and real-world problem-solving, fostering a deeper understanding of carbon neutrality and climate change.

Photos Romania 4: Students' science-actions projects.

3.4 Secondary Students as GREEN ENERGY RESEARCHERS reducing costs with effective electricity consumption at home

Authors: secondary school students of Stefan Luchian” School Moinești, teacher Tăbăcariu Anca, Gabriel Gorghiu and Mihai Bizoi.

This initiative presents an open schooling science action about Green Energy, which was developed by “Stefan Luchian” School Moinești, teacher Tăbăcariu Anca, during 2021-2022. The activities were supported by VUT.

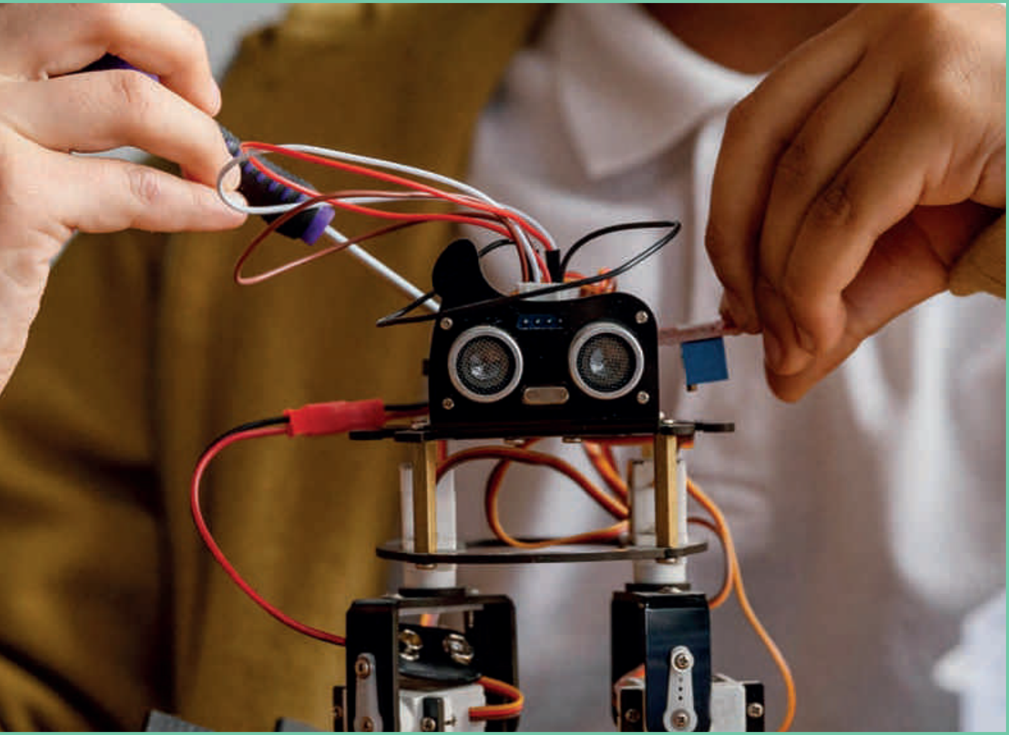
CARE:	The students were interested in how we can obtain green energy and whether using them reduces energy costs. Using the link to the project application, students could see the difference between costs using classical energy and green energy. 30 children (eighth grade) participated in the activities.
KNOW:	Students used knowledge of chemistry and physics, such as electrical power, electrical energy, electrical circuits, Joule’s law. The competences that students practiced were elaboration of questions, analysis of scientific data, discussion of claims and evidence, application of calculation formulas, formulation or writing of conclusions.
DO:	At the end, students prepared posters and boards with classical energy versus green energy, calculated the electrical power, as well as the electricity consumption for household consumers). They carried out the activities in groups and were supported by families and teachers.

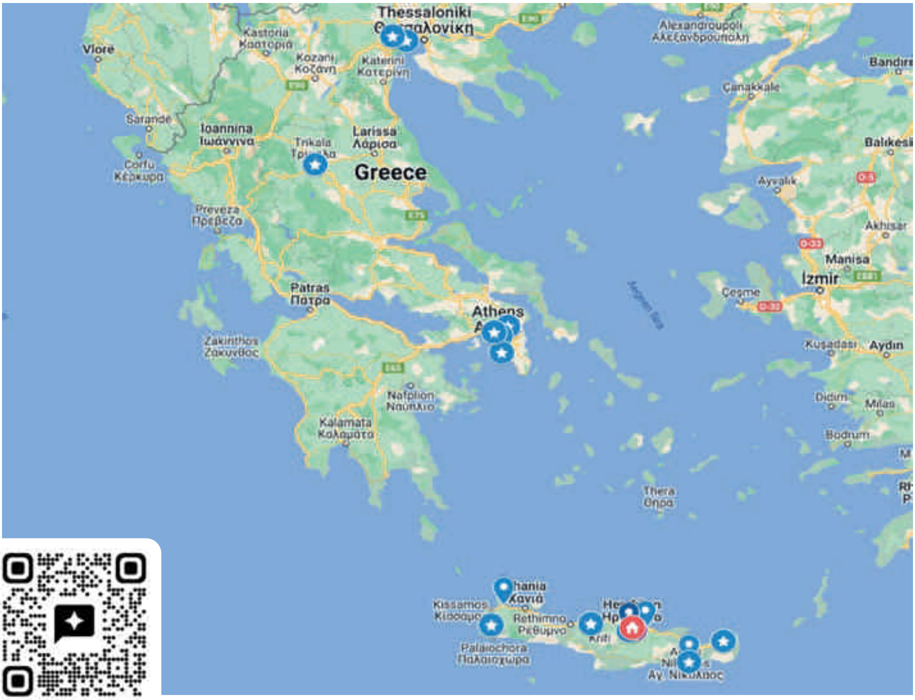
RESULTS: Findings related to the Open Schooling approach indicate that the activity can be framed in the curriculum. It was useful for students in physical discipline because they numerically calculated the values of electricity for classical consumers. Student results show that they were actively involved and gladly participated in the activities. Their posters were presented to the school community and contributed significantly to increase awareness.

Photos Romania 5: Students' making science-actions posters.

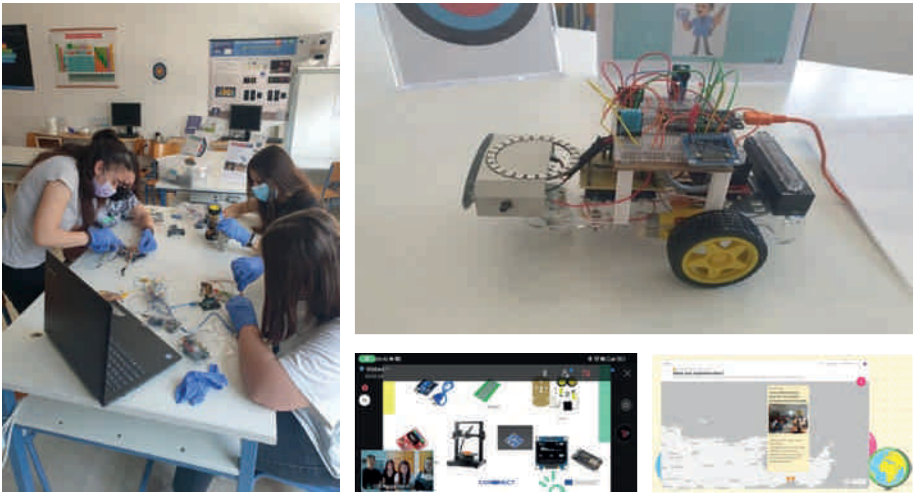
Case 4. Greece Science Actions driven by Youth

SDG 2 – Green Deal, Health, and Digitalization, Secondary school, 15-17




Thessaloniki
Θεσσαλονίκη
Kastoria
Καστοριά
Vlore
Kozani
Κοζάνη
Katerini
Κατερίνη
Alexandroupoli
Αλεξανδρούπολη
Bandırma
Çanakkale
Sarande
Ioannina
Ιωάννινα
Trikala
Τρίκαλα
Larissa
Λάρισα
Greece
Corfu
Κέρκυρα
Balıkesir
Ayvalık
Preveza
Πρέβεζα
Akhisar
Manisa
İzmir
Patras
Πάτρα
Çeşme
Athens
Kuşadası
Aydın
Zakinthos
Ζάκυνθος
Nafplion
Ναύπλιο
Didim
Milas
Kalamata
Καλαμάτα
Bodrum
Thera
Θήρα
Chania
Χανιά
Kissamos
Κίσσαμος
Rethimno
Ρέθυμνο
Heraklion
Ηράκλειο
Palaiochora
Παλαιοχώρα
Ag. Nikolaos
Αγ. Νικόλαος

Map 5: CONNECT network of open schooling research schools in Greece.



Photos Greece 1: students girls' science actions using artefacts and coding.

4.1 Secondary girls as GREEN DIGITAL ENTREPRENEURS using artefacts and coding for Green Digital Transition

Authors: secondary school students and GEL MACRY GIALOU and the educator Anna Karaiskou, Antonis Fountoulakis and, Giorgos Panselinas.

There is growing evidence that carbon dioxide levels in buildings are closely linked to the airborne spread of infections. Carbon dioxide is produced by the exhaled air of people living inside a room. The aim of the scenario is for the students to reflect on how diseases are transmitted in closed spaces, the role of CO2 and other parameters in the transport of airborne particles into them, while the ultimate goal of the scenario is for the students to develop a sensitive sensor to measure airborne particles using elements that already exist in science laboratories or that can be obtained by simple means such as Arduino microprocessors.

This good practice presents an open school education initiative, developed by GEL MACRY GIALOU and the educator Anna Karaiskou from 10/10/2021 to 1/5/2022. Scientists participated in the activities. This practice was repeated in the year 2021-2022 in another context and another structure, by the same teacher as well as the teacher Antonis Fountoulakis who are also the authors of this open scenario.

CARE: In this phase, students' curiosity and need to upgrade their knowledge level are stimulated, pre-existing ideas are explored, and prior knowledge is activated. Interest and participation were fostered through real work based on a community problem, in this case the control of Covid-19 and ways to build a sensitive sensor device. The concerns and needs related to the problem are identified, the challenges are investigated and the affected social actors to be involved are prioritised. To engage students by inviting them to participate in a participatory research project to develop strategies for the prevention and control of Covid-19 (and other similar infectious diseases) and to consider how it is possible to build the study device themselves. They begin by first exploring their concerns and needs with their families and then prioritising the challenges that need to be explored. The scenario is based on the need for more direct communication in the classrooms without losing the sense of security. The students who took part in the activities were 15–17-year-olds who were studying at the Lyceum. A total of 35 students participated in the whole process.

KNOW:

This phase facilitates the acquisition of knowledge and the development of the scientific skills and attitudes required to address the issues under consideration. Students used knowledge of physics, chemistry, and programming. The skills the students practised were:

- To understand how to deal with a topic-challenge that they find interesting.
- To acquire research skills.
- To understand that often in each target problem there is a conflict of interests and to realise the existence of different approaches.
- Formulate proposals-recommendations to the citizens and agencies involved.
- Well-informed discussion, communication, writing, interpretation, drawing and presenting conclusions based on knowledge.
- Collaboration.

DO: In this phase, students applied the knowledge and skills acquired to develop the final product assigned to them. In this case, the final product was titled "Development of a sensitive CO2 sensor for the control and protection against viruses such as SARS-CoV-2 in closed spaces". Studies and means of achievement were summarised and shared in an open letter. A school scientific conference was organised, where groups of students presented their work and proposals to the educational community. Representatives of policy makers and other relevant bodies were invited to the conference. The project was also presented at the 4th Panhellenic Scientific Conference P.D.E. Crete in May 2022.

RESULTS: Community participation in the Connect-Horizon 2022 program discussed the vital role that education plays in preparing students to collaboratively address global challenges and local issues facing humanity today. Students (girls) explored various issues such as global warming, climate change, environmental destruction, disease, and inequality. Students' contact not only with teachers but also with scientists and policy makers makes them think together and learn science to address global and local problems.

The change/innovation was supported by the school management, school association/network and Local government.

The purpose of this Project was to create the right conditions for the students to develop a scientific way of thinking in their daily life. Low cultural familiarity with science, lack of role models, insufficient exposure to experimental methods of inquiry, as well as limited opportunities to participate in science outside of formal education led to a lack of "scientific capital". The solution is to add more opportunities to the curriculum for these students to learn what scientists do, talk to their families about science, and appreciate the impact of science on the world. The satisfaction level of the children after the end of the project was great as they saw their efforts rewarded, they completed the construction successfully, they met many scientists with whom they solved several problems, and they communicated their results with great joy at the CONNECT conference.

This practice contributed to the increase of engaging families with sciences involving girls in science raising awareness among students about careers in the natural sciences. Parents participated in the collection of questionnaires for the student survey. The girls actively participated in the mapping and literature review and in general all students showed a special interest in digital maps and the contribution of geomorphological terrain to road construction.

4.2 Secondary students as INCLUSIVE WELLBEING ENGINEERS: making basketball with wheelchair safe

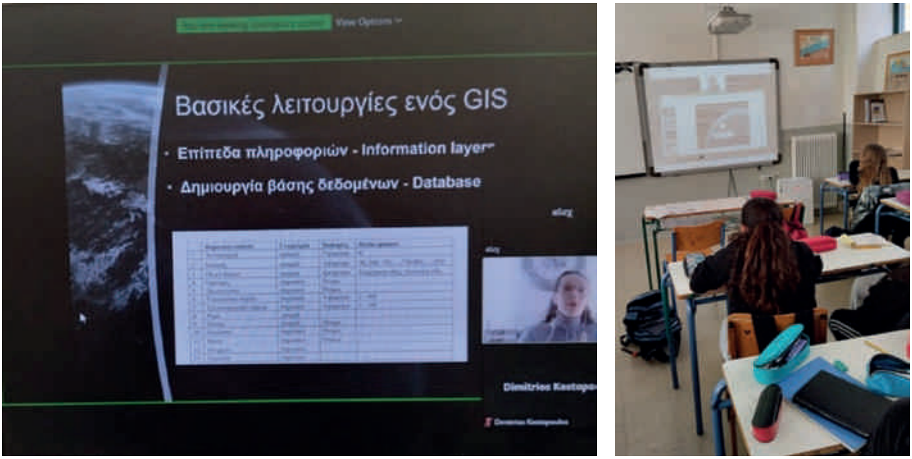
Authors: Students of the Experimental School of the University of Thessaloniki
Implementation Manager: Alexandra Nikolaidou PE.04.01
Participating teachers: Eleni Rossiou PE.86 Director , Sappho Fotiadou PE.04.01 , George Toumanidis PE.04.01 Implementation Classes: A and B Gymnasium; supported by Giorgos Panselinas.

This practice focused on supporting people with special needs using STEAM - Science, Technology, Engineering, the Arts and Mathematics. The area around the school does not always have the necessary ramps, crosswalks, and safe sidewalks for people with disabilities. Parked cars at crossings can further exacerbate the problem. But getting around the school grounds can also be particularly difficult if there are no ramps for wheelchairs or lifts. At the same time, visually impaired people may also have difficulty moving around school. Students' participants were supported by teachers from different subjects: Geography A and B Gymnasium, Computer Science, Skills Laboratory.

The scenario was compatible with the ALS. Mapping knowledge is applied in High School Geography and 3d design and electronic circuits in Computer Science and Skills Lab courses in the STEM module.

The thematic category was science and society. The scenario involved the familiar environment of students in the field of awareness, data collection and the possibility of parents and guardians of people with disabilities who need help to access the school premises.

Involvement of science experts and institutions: Online briefing, via teleconference, with the Geological Department of the Aristotle University of Thessaloniki where the Professor of Geology Mr. Kostopoulos as well as the PhD candidate Zoe Pantazopoulou of the Department inform students about the use of GIS software in the creation of interactive maps.



Βασικές λειτουργίες ενός GIS

- Επίπεδα πληροφοριών - Information layer
- Δημιουργία βάσης δεδομένων - Database

Photos Greece 2: Online briefing about the GIS software.

A delegation of the club "Alexander the Great 1994" (member of the Federation of Greek Wheelchair Basketball Associations, UCITS) discuss with the children about their daily lives, the difficulties they face, the rules of wheelchair basketball and invite students to try, move and compete with a wheelchair.

CARE: Raising students' awareness through the activity:
COME TO MY PLACE.

The athletes of the club discuss with the children about their daily lives, the difficulties they face, but also how the rules of wheelchair basketball are the same as the basketball children play. In the end, the students themselves try to move and race in wheelchairs.

KNOW: Students learned about how to construct maps to scale by measuring the actual dimensions. The ArCGIS software and the Field Maps application of the mobile phone to create digital maps. The Tinkercad 3D software designs and creates electronic circuits using a microprocessor ARDUINO UNO. The creation of three-dimensional inscriptions with Braille. The creation of circuits with ARDUINO UNO, infrared distance sensor and buzzer.

DO: Student cocreated:

- the schoolyard and areas to scale and locate on the map the points where disabled people cannot access it.
- group digital interactive maps of the area around the school where there is a problem of access. I also involve parents in recording the signs.
- three-dimensional signs in Braille for the school premises.
- three-dimensional playground in Tinkercad software for people with disabilities.
- With the help of ARDUINO UNO, infrared distance sensor and buzzer, they built a device to detect obstacles for the visually impaired.

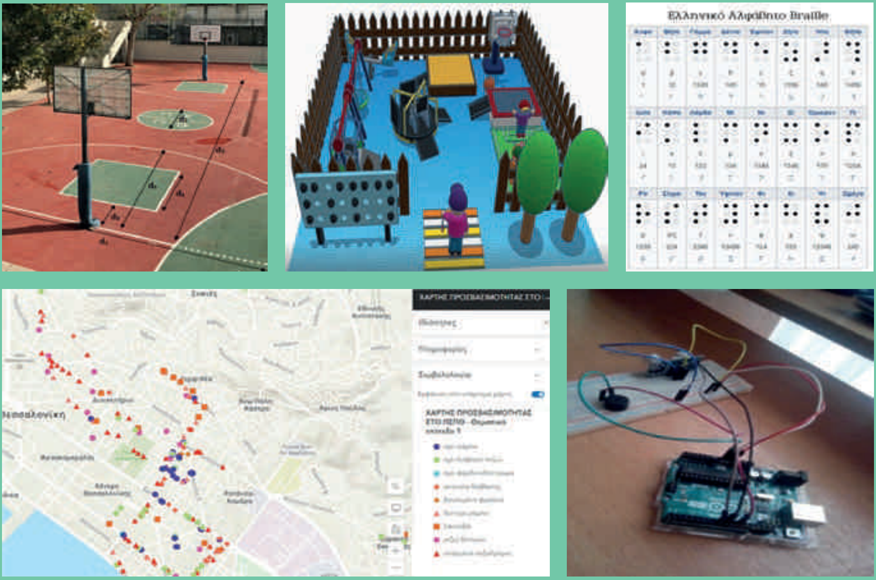
RESULTS: This scenario was in line with the following UN Sustainable Development Goals.:

3. Ensured healthy lives and promote well-being.

4. Ensured inclusive equitable quality of education.

8. Promoted sustainable, inclusive decent work for all.

11. Made cities and human settlements inclusive.


Ελληνικό Αλφάβητο Braille
ΧΑΡΤΗΣ ΠΡΟΣΒΑΣΙΜΟΤΗΤΑΣ ΣΤΟ

Photos Greece 3: students construct maps to scale by measuring actual dimensions.

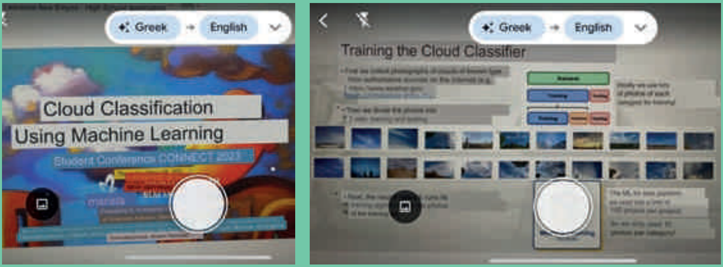
4.3 Lower Secondary Students as AI designers: Cloud classification through Machine Learning

> Authors: students of lower secondary School: Leonteios school Nea Smyrni;
> Teacher: Alexandros Kontarinis;
> Supported by: Giorgos Panselinas.

The following example, also developed by upper secondary students, refers to a science action about Cloud Classification using Machine Learning. The scenario focuses on Artificial Intelligence and was designed by the teacher of the school who followed the principles of designing open-schooling resources set by the RDE and CONNECT project.

CARE:	In this example, students collected a large database of clouds from authoritative sources on the internet. Then, students divided the photos into two sets: training and testing. The students were very excited to explore something very topical, such as Artificial Intelligence, to solve a real-world problem related to making predictions about the weather, temperature, and exploring its relationship with global warming.
KNOW:	Students built important knowledge about cloud classification and also practiced computational thinking skills and decision making regarding data management and machine learning performance.
DO:	Students also developed important communication skills to share this work nationally and internationally. The slides were well-prepared, and for those who could not understand Greek, they used Google Translate Lens.

RESULTS: This science action was presented at various events, including the school and the local community, the meteorology science center where professionals showed great interest, and finally, it was presented at the CONNECT school conference led by RDE.



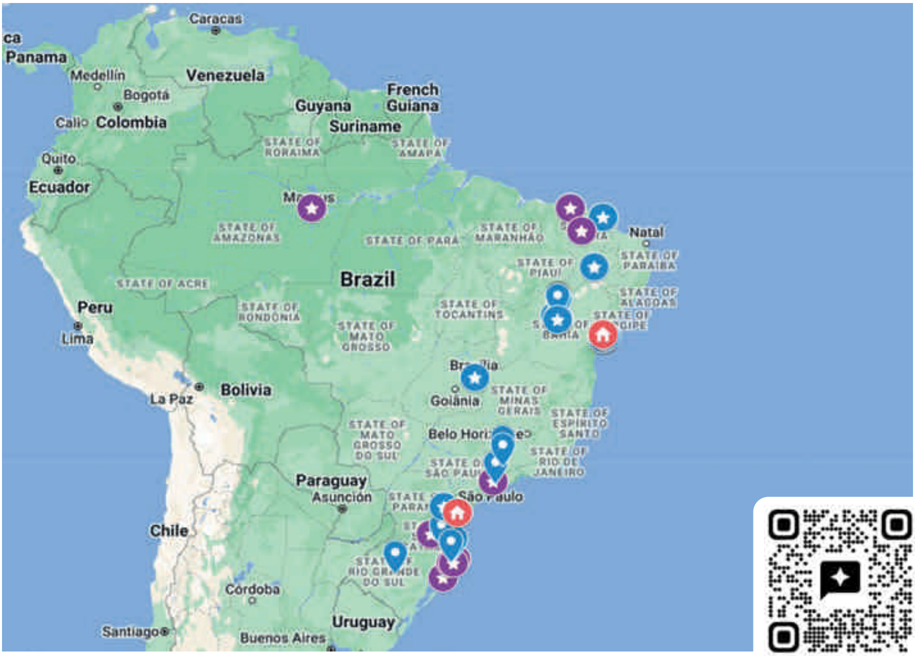
Cloud Classification
Using Machine Learning
Student Conference CONNECT 2023

Training the Cloud Classifier

Photos Greece 4: students' practice computational skills.

Case 5. Science Actions driven by Youth in Brazil

BRAZIL, SDG 1, 3, 5, 8, 9, 10, 14, 15, Primary and Secondary School


Caracas
Panama
Medellín
Venezuela
Bogotá
Guyana
French Guiana
Suriname
Cali
Colombia
Quito
Ecuador
STATE OF RORAIMA
STATE OF AMAPÁ
STATE OF AMAZONAS
STATE OF PARÁ
STATE OF MARANHÃO
Natal
STATE OF PARAÍBA
STATE OF PIAUÍ
Brazil
STATE OF ACRE
Peru
Lima
STATE OF RONDÔNIA
STATE OF MATO GROSSO
STATE OF TOCANTINS
STATE OF ALAGOAS
STATE OF SERGIPE
Goiânia
STATE OF MINAS GERAIS
La Paz
Bolivia
STATE OF ESPÍRITO SANTO
STATE OF MATO GROSSO DO SUL
STATE OF RIO DE JANEIRO
Paraguay
Asunción
São Paulo
Chile
Córdoba
Santiago
Buenos Aires
Uruguay

Map 6: CONNECT network of open schooling research schools in Brazil.

Photo Brazil 1: students assembly presenting science actions to scientists and communities.

5.1 Primary students as ENVIRONMENTALIST SOLUTIONS SEEKERS to address Local Stream Pollution in Ponta Grossa

Authors: Secondary school students, 7-11; Teacher Regina Liberato Shibuta; Researchers: Patricia Torres and Raquel Kowalski PUC-PR.

This open schooling initiative centres around the implementation of the open scenario-co-creation in a basic education school situated in Ponta Grossa, Paraná, Brazil. Teachers, unaccustomed to this approach, face a significant challenge of integrating real-life problems into their curriculum and subject domains. To address this, the CARE-KNOW-DO framework of the CONNECT Project was employed, facilitating the implementation of the concept of open schooling. This involved collaborative, exploratory, and scientific learning experiences both within and outside the school, involving scientists and members of the local community. Through a collaborative effort between educators-researchers from PUC-PR and teacher-practitioners, the focus was to explore in what ways addressing real-world problems identified by students enhance teaching methods. A mixed methods study was conducted, utilising observations, in-depth interviews, reports of teacher practices, self-reflective instruments.

The participants included four principals, four assistant professors, one pedagogical coordinator, one biology teacher, environment specialists, five scientists, and 71 students aged between 7 and 11 years.

CARE: During a visit to the local lake, teachers and students raised a variety of thought-provoking questions regarding the unpleasant smell, garbage accumulation, contact information for area improvement, and other aspects that mattered to them.

KNOW: This immersive experience enabled students to acquire knowledge about pollution, watersheds, groundwater, riparian forests, topography, sustainability, recycling, and citizenship.

DO: Engaging tasks in the 'do' phase, such as formulating questions for specialists and attending a lecture by the former mayor who inaugurated the site, further enhanced their learning. Students also explored the site themselves and developed hypotheses to address the pollution issues impacting local streams.

RESULTS: Educators found that students' inquiries helped transform their teaching practices and foster the development of new skills. The CARE-KNOW-DO open schooling approach enriched the curriculum, infusing it with engagement, relevance, and a connection to real-life scenarios. Though it posed challenges for teachers in terms of continuous learning and adaptation based on students' questions, this approach contributed to their professional growth. Teachers successfully sparked curiosity, facilitated enjoyable and relevant activities, and promoted divergent thinking among their students. According to the self-assessment data, 100% of teachers reported an increase in these abilities, expressing that "The open schooling with CARE-KNOW-DO expands the school curriculum, and provides lightness and reality to the presented contents by offering information and support for ongoing teacher education".

"The transformation encompassed the adoption of teaching strategies that enhanced learning centre approaches and fostered community awareness through student-led campaigns. The students displayed remarkable engagement, actively participating in every phase of the project. Their curiosity extended to topics such as pollution, water distribution, and energy consumption, prompting them to identify new problems and undertake projects within the school. Survey results indicated that 77% of students found science to be useful, 80% felt confident discussing scientific topics, and 83% expressed enjoyment in learning science. One student expressed, "It feels amazing to go to a school that actually cares and backs us up in making a real impact in our local community."

5.2 Agricultural school students as ANTI-MICROPLASTIC ACTIVISTS for Sustainability, health, and life in the countryside

Authors: 23 Secondary schools more than students of rural areas of Department of Professional Education of the State Department of Education
Researcher leader: Patricia Torres,

This good practice reports an initiative of Open Schooling on the implementation of the CONNECT Project, which was developed by the team of the Department of Professional Education of the State Department of Education - Vocational High School - led by the State Coordinator of Agricultural Colleges, Renato Hey Gondin, in partnership with 23 agricultural college directors. It took place in the management of Secretary Roni Miranda Vieira. The activities involved teachers from the 23 participating schools with backgrounds in agricultural areas such as veterinary and agronomy. The partnership was supported by the PRAPETEC research group from the Pontifical Catholic University of Paraná. We used the open scenario method, with the participation of 1st, 2nd, and 3rd-year students from the agricultural technical course.

CARE: The issue of microplastics has attracted significant attention. These tiny plastic particles, less than 5 millimetres in diameter, have infiltrated our ecosystems and caused irreparable damage to marine life and human health. In order to raise awareness among students about this issue, initiatives were implemented in schools, aiming to create a generation committed to preservation. It is important to engage students in practical activities, such as beach and river clean-ups, proper separation of plastic waste, and the production of educational materials. The students involved in the project come from rural areas that lack basic services such as garbage collection and treated water. Raising awareness among these students from rural areas about proper waste disposal is an important task to promote environmental preservation and sustainability.

KNOW: The pre-existing knowledge about the topic was assessed and it was found that very little was known about microplastics and their impacts. In this context, all students enrolled in the 23 agricultural schools in the state of Paraná were invited to watch an awareness video about the environmental problems caused by microplastics. From that moment, the students were invited to discuss the topic and share how they handle domestic waste in their rural area, leading to a self-assessment of the practices employed on their rural property and their responsibility towards the environment.

DO: In the end, the students were invited to participate in an action at the school, which consisted of collecting solid pollutants. Divided into teams, the students collected pollutants throughout the school grounds. They noticed the lack of trash bins and possible adjustments needed in the institutions to enable selective disposal and recycling. The students were surprised by the number of materials collected, considering the school appeared "clean." After the collection, the students participated in the separation and delivery of the materials to recycling entities.

They also created videos and promotional materials for social media, aiming to raise awareness among the school community and their groups of friends and family.

RESULTS: Open Schooling emphasises individualised education, allowing students to choose their own interests and learning rhythms. The autonomy of the student was emphasised, enabling them to take responsibility for their own learning, which generated engagement and motivation, leading to satisfactory results. The learning in this work was based on projects, where students had the opportunity to investigate and explore, making the activity challenging. It promoted the application of knowledge in real contexts and developed skills such as research, problem-solving, and teamwork.

The use of technology facilitated learning, as digital resources allowed students to access learning materials. As previously mentioned, the topic involved was unfamiliar to the students, and since it is a relatively new subject, it is not yet available in the materials provided to students.

The development of socio-emotional skills was remarkable during the activity, and it was observed that skills such as collaboration, critical thinking, and problem-solving were evident. The students engaged in the activity with a shared purpose and worked together.

The students showed awareness and civic engagement, demonstrating concern for the presented problem, and seeking practical solutions in their discussions to minimise the issue in their communities. Their intentions went beyond individual actions and addressed the collective, proposing solutions for the entire community.

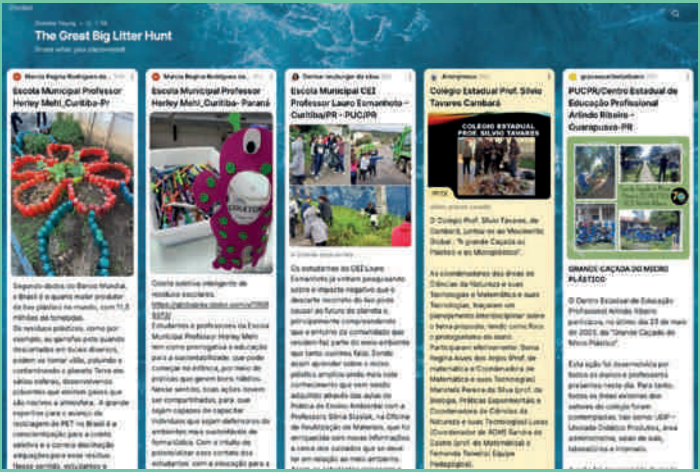

The Great Big Litter Hunt
Escola Municipal Professor Herley Mehl_Curitiba-Pr
Escola Municipal Professor Herley Mehl_Curitiba- Paraná
Escola Municipal CEI Professor Lauro Esmanhoto – Curitiba/PR - PUC/PR
Colégio Estadual Prof. Silvio Tavares Cambará
COLÉGIO ESTADUAL PROF. SILVIO TAVARES
PUCPR/Centro Estadual de Educação Profissional Arlindo Ribeiro - Guarapuava-PR
GRANDE CAÇADA DO MICRO PLÁSTICO

Photo Brazil 2: students' science actions with in partnership with 23 agricultural college directors.

5.3 Upper secondary students as GREEN ENERGY ENGINEERS targeting enterprise-funded innovation

Authors: Secondary students of Professora Maria das Graças Alves Costa school. Adriana Florentino Da Silva, Anderson Duarte Vilas Boas, Gerson Ribeiro Dos Santos, Mailce da Conceição Gonçalves, Rocy Rocha Ferreira.
Ana Karine Rocha, Silvar Ribeiro, Sonia Pinto,

ENERGIA
SOLAR

Photo Brazil 3: students' science actions with communities in Bahia

This report highlights an exemplary initiative in Open Schooling focused on promoting sustainable actions in everyday life. The project took place at the Municipal School Professora Maria das Graças Alves Costa from July 7, 2022, to December 15, 2022, involving students and teachers in the field of basic education science. Its primary goals were to foster scientific education and spark interest in scientific careers. Additionally, families and scientists were invited to participate and contribute to discussions on the topic.

The project, titled "Environmental Sustainability and Renewable Energy," was carried out in collaboration with the State University of Bahia - UNEB, as part of an international consortium with support from the European Commission. It followed the methodology of Connect and encompassed three distinct stages:

CARE: Through reflective classroom activities, students in the 8th and 9th grades recognized the need for changes in consumption habits to safeguard the planet’s ecosystems. As they faced the reality of energy usage in even the most basic activities, the students pondered how it would be possible to utilise energy without inflicting significant harm on nature.

KNOW: Leveraging their knowledge of energy sources, the students conducted in-depth research on the topic. They honed their ability to identify various forms of energy production prevalent in the Brazilian context, distinguishing between renewable and non-renewable sources.

DO: In the final phase, students formed groups and employed reusable materials that would otherwise be discarded to construct models. They shared their newly acquired knowledge with younger peers and provided their families with information on reducing electricity consumption at home. Furthermore, they were encouraged to participate in the National Energy Efficiency Olympiad, a nationwide competition among schools. Remarkably, the projects submitted by the students from Professora Maria das Graças Alves Costa School, linked to CONNECT, earned a total of 21 medals.

RESULTS: Key findings related to the Open Education approach revealed that the curriculum-based activity proved highly valuable in enhancing students’ learning experiences. The project posed a significant challenge as it necessitated understanding and mapping energy production processes, along with their implications for nature and biodiversity. Notably, the innovative aspect of the initiative was evident in how students utilised discarded materials to create models, facilitating their grasp of essential technological and scientific advancements. The Open Schooling program, led by a group of dedicated teachers and their students, garnered attention throughout the entire school due to the remarkable engagement and achieved results. The exhibition of the project outcomes was met with enthusiasm and sparked the interest of other students and teachers in the school.

The results achieved by the students demonstrated their profound involvement and enthusiasm throughout the entire process. Beyond acquiring valuable knowledge, which they eagerly shared with their families, the students had the opportunity to extend their impact beyond the school boundaries by participating in the National Energy Efficiency Olympiad. This competition involved gamified elements, such as questions and challenges. Despite initial nervousness, one student expressed happiness in being able to share information that can positively impact people's lives, particularly when presenting to younger classes.

5.4 Upper secondary students as NATURE-BASED SOLUTIONS ENTREPRENEURS driving Transformation in Agribusiness through Bioplastics

Authors: Secondary school students: Secondary school teachers:
Rita de Cassia Viana Cerqueira; Elizabete Guedes Conceição; Uneb teachers
Sônia Maria da Conceição Pinto & Silvar Ferreira Ribeiro.

Photo Brazil 4: students' explore the production of bioplastic using cassava waste.

Through the practice of open schooling, students were encouraged to identify problems and find solutions, supported by scientific research. The aim was to boost students' confidence and aspirations to pursue careers in science by engaging with socio-scientific dilemmas under the guidance of professors and scientists. Several research activities were conducted, all aligned with open schooling practices.One topic that particularly interested the students was the Vegetable ROOT Fair, which focused on the proper disposal of organic waste generated at the local free fair in Camaçari Bahia Brazil.

CARE:	Students explored the production of bioplastic using cassava waste containing a significant amount of starch, polymerized to generate bioplastic.
KNOW:	Organic materials degrade naturally and contribute to processes like the carbon and nitrogen cycles. However, improper disposal of organic waste poses serious environmental risks, compromising soil and water health, exposing populations and animals to toxic substances, and wasting valuable resources.
DO:	Capitalising on the thriving cassava market in Camaçari, traditionally used in Brazilian cuisine, a routine for collecting organic materials was developed to manufacture biodegradable plastic. This work increased awareness about responsible waste disposal, contributing to positive impact for society, economy, and environment.
RESULTS:	Following the completion of Science Action projects involving bioplastic production including the interaction with researchers and the local community, a questionnaire was administered to CETEP students as part of the CONNECT project. The questionnaire aimed to gather opinions on science and participation in the project. When asked about the usefulness of learning science in their lives, 89% agreed, while only 12% expressed uncertainty. This highlights the importance of initiatives like the CONNECT project in developing and enhancing experiences that stimulate reflective critical thinking and promote scientific capital among young students with purpose and usefulness.

One student's testimonial stood out, emphasising the step-by-step process of starting, producing, guiding team members, and assuming a leadership role within the CONNECT project. This highlights the significance of the different phases in the project, supported by the "CARE-KNOW-DO" approach. Another student expressed the need for greater promotion of science, describing it as a thought-provoking activity that opens eyes to the world and generates interest.

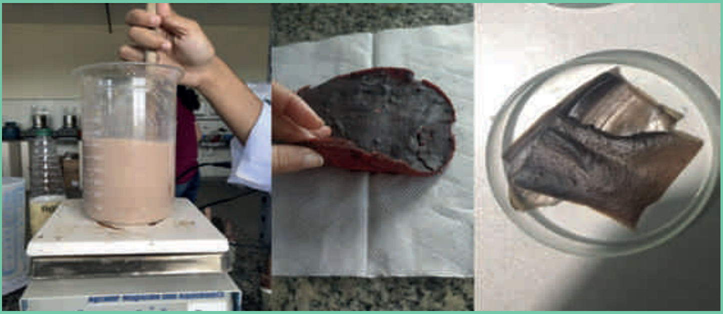


Photo Brazil 5: students' make bioplastic.

In summary, students were empowered with knowledge, skills, attitudes, and values that enabled them to transform their lives, economy, environment, and communities. This was achieved through challenges that are relevant to them (CARE), the knowledge they acquire and discuss (KNOW), and the transformative actions they undertake (DO). Importantly, the project garnered significant involvement from teachers, students, and communities, underscoring the crucial role of open schooling and scientific education in fostering greater social, economic and environmental awareness.

5.5 Primary pupils as ENVIRONMENT-PROTECTION POLICY-MAKER URBAN FOREST to protect animals from car drivers

Authors: reception and primary school pupils of schools supported by the Secretaria of Education of Maripora, Marcia Bernardes, Alexandra Okada.

Photo Brazil 6: students' science actions with communities in Mairiporã.

This practice reports an open schooling initiative on THE ANIMALS OF THE URBAN FOREST developed in the city of Mairiporã, located in Serra Cantareira in the State of São Paulo, Brazil. Mairiporã is recognized for having the largest urban forest in the world. This project was promoted by the municipal secretary of education of Mariporã, which supported a large network of schools from February to September 2022. Activities included student interaction with the zoo professionals and scientists from the animal protection centre, access to the forest reserve website, including Youtube Videos about the animals. These specialists in the fields of biology, zoology, veterinary medicine, and others received students to discuss the real issues related to the problems that the community faces, such as what to do when they run into a forest animal in their backyard; who to contact if the animal is injured; what to do to protect the animals and preserve their natural habitat. The partnership for this open schooling initiative was supported by the Open University of the United Kingdom – responsible for teacher training to expand the knowledge and pedagogical practices related to open schooling, scientific capital and affective engagement.

CARE: Approximately 650 students from Early Years Education, Elementary School, and Low Primary Education engaged in investigating a theme of their interest: the animals. They were concerned about those animals they found in their city, and even in their backyard, which were injured or lost from their natural habitat. Their interests engaged them in several activities involving the project. Many of them were led by their natural curiosity expressed in various questions addressed to the science professionals, and in the conversations with their teachers and family. They learned science through a real-life problem involving their families and experts.

KNOW: Students learned about animal types and classification, names, and differences, including behaviour, habits, environment, and food. In addition, students not only developed skills such as asking questions, drawing, writing, reflecting on school assessment, communicating their conclusions, but also experienced discussions about the voting system and data analysis with maths.

DO: At the end, students created drawings, posters, campaigns and infographics with maths data, games, and interviews with printed and online resources. They developed the activities individually and collaboratively with experts, family, and community members.

There was a school who also developed activities about the Green Library- care-know-do book. At the end, all students discussed their views related to science in their lives and society with the self-assessment mobile application CONNECT-SCIENCE tool.

RESULTS: The structured activity allowed a connection with the curriculum in an interdisciplinary way. Children developed knowledge, skills, attitudes, and values with activities in science, mathematics, geography, and Portuguese language communication. It was a useful, relevant, challenging, and innovative project as it involved many schools and teachers. Students demonstrated increased engagement, enjoyment of scientific activities, such as: observation in the forest and zoo; analysis and comparison of animal data sheets; discussion of concepts; communication skills, like oral, visual, and written competencies. As an example, a pupil (age=6) mentioned that science is important and recorded a short video at home on her cell phone expressing her views on what science means to her. By the same token, other students (age=9) manifested their learning and new knowledge by stating: "Science is not just about doing experiments in the lab; it helps us think about how to help the world"; "I learned about the characteristics of forest animals, types of habitats and how to protect them; "Deforestation is increasing, and we need to do something." At the end of the project, the youngest students (4-6) wrote a letter asking the authorities to add a driving sign (ANIMAL – TAKE CARE) for drivers not to kill animals while driving in that area. The board was done by the municipality; children found the experience very valuable and unforgettable.

Students completed also the open schooling activity about the book "OUR GREEN LIBRARY: CARE-KNOW-DO". With researchers and their school' community they discussed "what is open schooling? what is the benefits of discussing science issues and solutions with their families and community?

All students (100%) considered that science will be useful in their lives. 88% found the activities fun and would like to be seen as a science-expert, but only 53% feel confident with their knowledge in science.

Students reported that *"The story activated my imagination, curiosity, and the pleasure of learning with others". (Girl, age 9) "Open schooling is about being open to solving problems with people and helping the community". (Boy age 8)*

This study reveals positive perception of participants regarding open schooling through digital storytelling. Students can apprehend its meaning and experience how to learn with teachers, professionals, and citizens. The storytelling activities create an opportunity for engaging students using science to discuss problems and solutions within and beyond school. Following is an example that summarises the book produced by an older student from the UK.

"A girl goes to her local library in her favourite park. When she leaves it, she discovers that she just stepped out of her memory and her childhood favourite park is in ruins. The girl-now a woman in her 40s- and her young daughter try to bring back the tropical park. The pain is about facing the harsh reality of having a precious childhood and environment decayed and facing the digital divide gap, of generations, with frightened thoughts that the future is getting worse. The world is fading fast. The girl and the daughter have a glory of complementary skills and power to make changes with open schooling partnerships, supported by the precious 'fun' lived in the past and hope for the future."

Lili, aged 13. URL about the book.

Our Green Library
care
know
do
Alexandra Okada
With illustration by ALYS KIANA SHERBORNE

5.6 School Community members as LIFE-RIGHTS ADVOCATORS to support sustainability in Amazon

Authors: Students, teachers, researchers, and families
Colearn Network & Alexandra Okada.

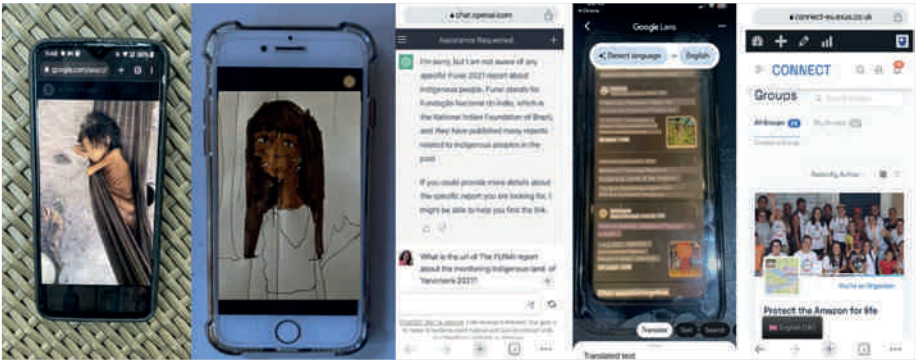


Photo Brazil 7: Brazilian and UK students' science actions with communities about Amazon.

This open schooling initiative presents a case study conducted in 2023, in which six students, six British and two Brazilians living in the UK, aged between 13 and 15, along with two mothers from Brazil and the UK, a science educator, and a science technology researcher, embarked on an engaging investigation about environmental protection of the largest rainforest Amazon. The activities were conducted outside the curriculum but had connections to biology, mathematics, and geography.

CARE: The students relied on the internet to research about the topic. They used their mobile phones to find the key issues: increasing threats from large-scale farming and ranching, infrastructure and urban development, unsustainable logging, mining, and climate change. They were asked to evaluate the sources found, Economist (2022), Animal Equality UK (2022), and UNEP (2023); which proved challenging for them to read. This led to a discussion about the importance of reliable sources that are easy to comprehend. When searching for photos related to these issues, the students immediately became concerned, particularly when they came across images of children who appeared malnourished. These images sparked their compassion, they formulated initial questions: “Can we protect the forest?” “Which beings are in danger?”

KNOW: The study of rainforests in the UK varies across different age groups and school levels. In primary schools (ages 5-11), rainforest topics may be introduced in geography or science lessons, covering characteristics, location, climate, biodiversity, and conservation. In secondary schools (ages 11-16), rainforest studies become more in-depth, focusing on aspects like rainforest structure, organism interdependence, deforestation impacts, and sustainable management. At the A-Level or Advanced Highers level (ages 16-18), students choosing geography, environmental science, or biology can further explore rainforests, including tropical ecosystems, ecological processes, and conservation strategies. However, students had limited knowledge about the social and economic factors influencing rainforest regions. Initially they struggled but were able to connect these concepts between science with geography.

DO: Searching for information on the issue using Google and AI-Chat-GPT from the perspectives of biology and geography proved valuable for the students to discuss and refine their questions. As they accessed more information, they were able to delve into more detailed and comprehensive inquiries. The discovery of certain images prompted the question, “What happened to the Yanomamis?” However, despite being familiar with internet research, they faced difficulties finding information in English, as some sources were in Portuguese. The mothers actively participated in the discussion, raising their own questions based on the students’ concerns. They asked, “What could be the consequences for the Earth without the Amazon rainforest and its peoples?”

RESULTS: Students found AI-chat incredibly useful, faster, and providing more information. But when the educator asked which source they selected, they were not able to answer nor the mothers. They then asked ChatGPT about the sources and used Google to find the URL to see the validity of the information. New questions emerged:

“Where can I find reports on indigenous lands?” “How can we meet students and scientists, both in Brazil and in the UK, how could we protect the Amazon?”

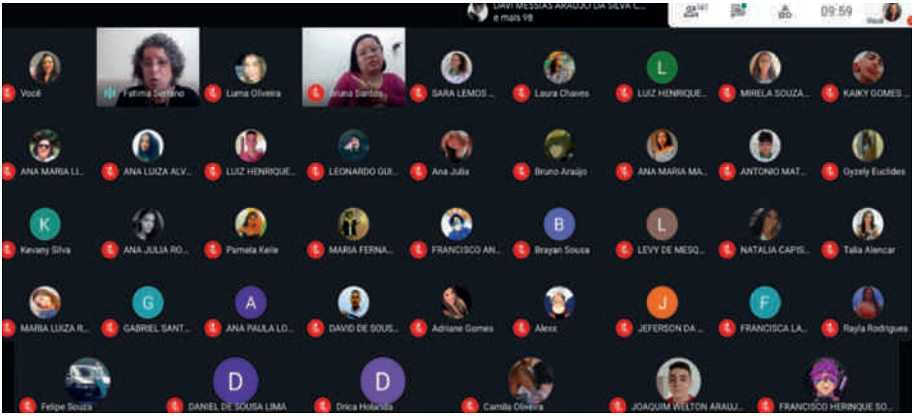
The study emphasised the importance of protecting the environment, including plants, animals, and indigenous peoples, who face significant threats from illegal exploitation and deforestation. It followed the DigComp Framework, incorporating information literacy, communication, digital content creation, safety, and problem-solving. Using the CARE-KNOW-DO model, students actively engaged in research, collaboration, and personalised learning experiences.

The study connected learning to real-world challenges, culminating in the creation of an investigative map called "Protecting Life." The map explored various aspects, such as feasibility of protection, endangered species, challenges faced by indigenous communities, and the consequences of losing the Amazon rainforest. The study fostered critical thinking, collaboration, and increased student engagement. Acquiring knowledge about the Amazon's biodiversity, indigenous culture, and climate impact is vital for European children, promoting global citizenship and interdisciplinary learning for a sustainable future.

"The Amazon Rainforest has a big problem. Trees and indigenous people are being hurt and nobody talks about it in school. Have you seen that picture of the Yanomami kids? It looks like those Nazi camps, it's really scary. We have to do something about this violence, it's just too brutal.
So, I was using Google and found this new thing called ChatGPT. It's like magic! It gives me quick and clear answers, much faster than Google. But you know what? I realised that I can't always be sure if what it says is true. So now I use different search engines to check.
I talked to some researchers and my Brazilian friends, and they taught me this cool trick with Google Lens. It helps me translate internet pages really fast, especially when they're in Portuguese. I found out that there's a lot more information about the Amazon written by Brazilians, but it's not always in English."
Learners Team.

5.7 Secondary students as WOMEN-WELLBEING RIGHTS ADVOCATORS increasing awareness of physical & mental violence and pedagogy of intervention to empower teachers

Authors: Students the municipality of Monsenhor Tabosa, Anjos digitais Rossana Moura & SEDUC - Karine Souza, Vagna Lima, Jacqueline Moraes.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e mais 98
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Você
Fatima Setino
Luma Oliveira
Bruna Santos
SARA LEMOS
Laura Chaves
LUIZ HENRIQUE
MIRELA SOUZA
KAIKY GOMES
ANA MARIA LI...
ANA LUIZA ALV...
LUIZ HENRIQUE...
LEONARDO GU...
Ana Julia
Bruno Araújo
ANA MARIA MA...
ANTONIO MAT...
Gyzely Euclides
Kevany Silva
ANA JULIA RO...
Pamela Keile
MARIA FERNA...
FRANCISCO AN...
Brayan Sousa
LEVY DE MESQ...
NATALIA CAPIS...
Talia Alencar
MARIA LUIZA R...
GABRIEL SANT...
ANA PAULA LO...
DAVID DE SOUS...
Adriane Gomes
Alexx
JEFERSON DA...
FRANCISCA LA...
Rayla Rodrigues
Felipe Souza
DANIEL DE SOUSA LIMA
Dnica Holanda
Camila Oliveira
JOAQUIM WELTON ARAUJ...
FRANCISCO HERINQUE SO...

Photo Brazil 8: Brazilian students' science actions with communities in Ceará.

This practice reports an open schooling activity with an open scenario developed by the NGO Anjos Digitais during the pandemic period. The activity was carried out in two public state schools in the municipality of Monsenhor Tabosa – a semi-arid region located in the state of Ceará – Brazil. It was supported by the Open University OU-UK.

CARE: The socio-scientific issue that the students care about was pregnancy at puberty and violence. Data during the pandemic shows that violence during the outbreak increased particularly against women and underrepresented groups.

KNOW:	To help young people be more informed during their puberty with knowledge, their online debate was supported by a dialogue focused on students' questions, some references shared by experts on the web and informed-based recommendations developed by the participants.
DO:	300 students interacted with five science professionals, a specialist in menstrual education, a doctor, a psychologist, a nurse, and a social worker. The science action focused on an interactive dialogue with inquiry mapping (Okada, 2023) to bring up questions, references and comments in the online discussion using Google Meet platform.
RESULTS:	The key benefit of open schooling mentioned by students was that the multi-actor dialogue led to greater awareness of teen pregnancy prevention and the forms of physical and mental violence that affect puberty. This initiative had the consent of the parents and created opportunities for dialogue between students and their family. Although this open schooling activity was not integrated into the curriculum, it was supported by teachers. Youth found the dialogue with professionals useful and listening to what other students think enabled them to increase their interest about the topic. In parallel the secretary of education of Ceara delivered a large-scale professional development for more than 10,000 teachers to enhance quality of education in conjunction with their pedagogy about intervention. These have some similarities which resulted into an adapted approach: students intervening in their communities to solve real-life problem underpinned by curriculum knowledge, citizens, and experts. A significant Transformation.

5.8 School-university students as AR-SCIENCE-TECHNOLOGY PARTNERS to raise science understanding with AR augmented reality in Health & Outside-the-box Education

Author: students of RA in Schools, Alexandre Marino Costa, Eliane Pozzebon, Marcio Vieira de Souza, Alexandra Okada.

Source A. Marino E. Pozzebon
RA

Photo Brazil 9: Brazilian students' science actions with communities in Santa Catarina.

This open schooling initiative was implemented by UFSC University and 12 secondary schools in Santa Catarina, Brazil, with the support of the Open University (OU-UK). The project involved more than 300 students between the ages of 11 and 15. The aim was to foster students' engagement by allowing them to explore a real issue that piqued their interest: heart diseases and their causes.

CARE:	To enhance their knowledge about the heart and its functions, the students utilised Augmented Reality (AR). They engaged with a 3D model of both a healthy and an unhealthy heart, leveraging AR to deepen their understanding.
KNOW:	The activities were developed in collaboration with professionals in medicine, as well as academic students in biology and computer science. These experts utilised AR resources developed by the OU, enabling the students to have a rich learning experience. Secondary school students found AR to be an effective tool for deepening their understanding of the heart. Interacting with professionals from medicine and computer science provided valuable insights into these fields, university life, and potential career paths. The students expressed a strong affinity for the activities and expressed their willingness to embrace this approach for learning other subjects.
DO:	One noteworthy outcome of the project was the students' decision to organise a workshop for their parents, where they showcased the effects of smoking, drug use, alcohol consumption, and unhealthy eating habits on the heart. This science-based action demonstrated the students' commitment to spreading awareness about the topic and consolidated their understanding.

RESULTS: The results from data generated by 135 students were encouraging. Most of them found science to be enjoyable. Teachers found the activities to be valuable additions to their curriculum, as they were both supportive and captivating. Parents noted their children's excitement and appreciated how AR facilitated better content understanding and discussion. Moreover, undergraduate students from the fields of medicine and computer Science realised the potential for developing more AR resources on different topics and in various areas. This interdisciplinary collaboration allowed them to engage with the school community and witness the positive impact of their contributions. The open schooling initiative developed by UFSC University and 12 secondary schools in Santa Catarina, Brazil, successfully engaged students in investigating heart diseases using AR technology. By incorporating professionals from relevant fields and aligning the activities with the curriculum, the initiative fostered student engagement, improved visual understanding, and communication skills. The positive outcomes of this project was expanded with more AR resources funded by MCTI of Brazil GOV freely available at https://raescolas.ufsc.br/en and the international event of OUTBOX EDUCATION for teachers' development both initiatives led by UFSC.

Photo Brazil 10: Brazilian students use augmented reality to understand the human body.

Case 6. Rewilding cross-communities network

Canada
United States
Mexico
North Atlantic Ocean
United Kingdom
Poland
Germany
Ukraine
Kazakh
France
Italy
Spain
Türkiye
Afghan
Iraq
Iran
Pakis
Algeria
Libya
Egypt
Saudi Arabia
Mali
Niger
Chad
Sudan
Nigeria
Ethiopia
Venezuela
Colombia
DRC
Kenya
Tanzania
Brazil
Peru
Bolivia
Angola
Namibia
Botswana
Madagascar
Chile
South Atlantic Ocean
South Africa
Argentina

Map 7: Students' science actions about Rewilding across the world.

A total of 1,387 students aged between 10 and 19 completed the Rewilding open schooling activity and questionnaire in 3 countries and 3 states of Brazil. Learners were from all grade levels in primary, secondary and tertiary education. The majority of students were at a state school (1,323) – some of which would be from lower socioeconomic backgrounds. Only 128 had parents in jobs that use science, meaning they are less likely to engage with science at home. Many students have access to a mobile phone with internet (1,171), but 11 do not have access to a computer, tablet or laptop at home.

The CARE-KNOW-DO pedagogy encourages students to identify real-world problems that matter to them. The majority of open schooling activities developed by the students were focused on green issues-Rewilding. This highlights how important these issues are to young people and shows a need to increase sustainability education within the curriculum. A variety of open schooling activities were used, the most popular being discussion, carrying out research and formulating questions- all important scientific thinking skills and those that are needed by students aspiring to scientific careers.

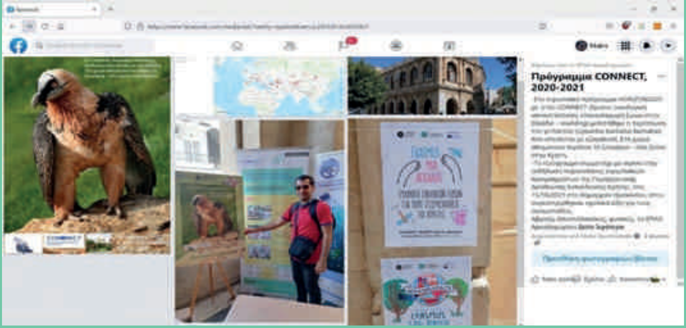
We saw a wide range of educators, other than scientists, involved in helping students, especially from the fields of chemistry and biology. This may help to inspire students to have scientific careers in fields that they may not have considered. Inviting students to CARE about real-world problems selected motivates them to KNOW and apply scientific knowledge supported by a teacher to DO actions towards problem-solving with scientists and families.

The issues most selected were environment and health; the most popular science-action was to do research, posters, and presentations.

CARE:	After completing a Science Action, most of students (70%) agreed that science will be useful in their lives and 77% agree that science helps people.
KNOW:	Just under half of students feel confident with their knowledge in science (48%) and in using science to come up with questions and ideas (49%).
DO:	Half numbers of students felt confident doing science projects (50%) but less than a half felt able to talk about science (40%). This data shows that students see the importance of science but more needs to be done to improve their confidence in their science knowledge and skills.

Photo R1: Rewilding Botos in Brazil South and Rewilding Precious Birds in Brazil Northeast.

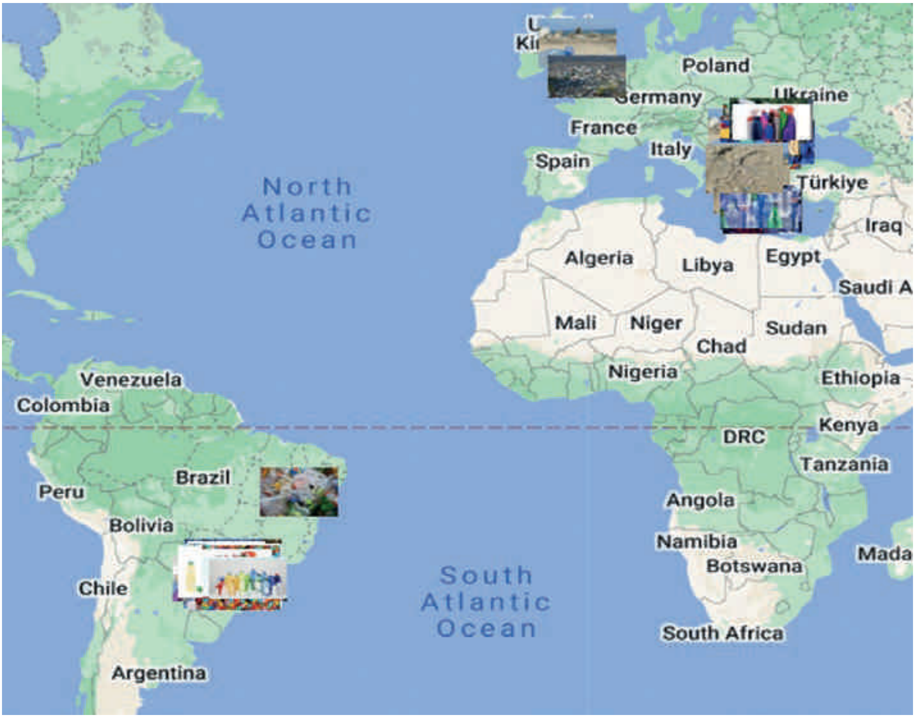
Photo R2: Rewilding Wolves in Romania.



Πρόγραμμα CONNECT, 2020-2021

Photo R3: Rewilding Wild Birds in Greece.

Case 7. Microplastic cross-communities' network


Poland
Germany
Ukraine
France
Italy
Spain
Türkiye
North Atlantic Ocean
Iraq
Algeria
Libya
Egypt
Saudi A
Mali
Niger
Sudan
Chad
Nigeria
Ethiopia
Venezuela
Colombia
Kenya
DRC
Tanzania
Brazil
Peru
Angola
Bolivia
Namibia
Botswana
Mada
South Atlantic Ocean
Chile
South Africa
Argentina

Map 8: Students' science actions about (Micro)plastic.

Map

Report A: Teachers

Report B: Students

Resources

Results

A total of **2590** students aged between **10 and 19** completed the Microplastic open schooling activity and the questionnaire. Learners from all grade levels in primary, secondary, and tertiary education. The majority of underserved students were at a state school from lower socioeconomic backgrounds.

Only 16% had parents in jobs that use science, meaning that 84% are less likely to engage with science at home. Many students have access to a mobile phone with internet (2332), but 18 do not have access to any technology nor internet.

The CARE-KNOW-DO pedagogy encourages students to identify real-world problems that matter to them. The majority of open schooling activities developed by the students were focused on green issues - plastic waste. This highlights how important these issues are to young people and shows a need to increase sustainability education within the curriculum. Other issues covered include materials, chemical pollution, and health.

A variety of open schooling activities were used, the most popular being discussion, carrying out research, deciding topics and formulating questions- all important scientific thinking skills and those that are needed by students aspiring to scientific careers. We saw a wide range of educators, other than scientists, involved in helping students, especially from the fields of sciences and others.

Inviting students to CARE about real-world problems selected motivates them to KNOW and apply scientific knowledge supported by a teacher to DO actions towards problem-solving with scientists and families. The issues most selected were Environment and health; the most popular science-action was to do research, posters, and presentations. Students enjoyed listening to the scientist Prof. Richard Thompson who created the term Microplastic. Students were very inspired by Prof. Thompson and enjoyed a lot to know how microplastic were detected and how he became pioneer of an important research in the world.

Resources and Results were freely available and largely disseminated.

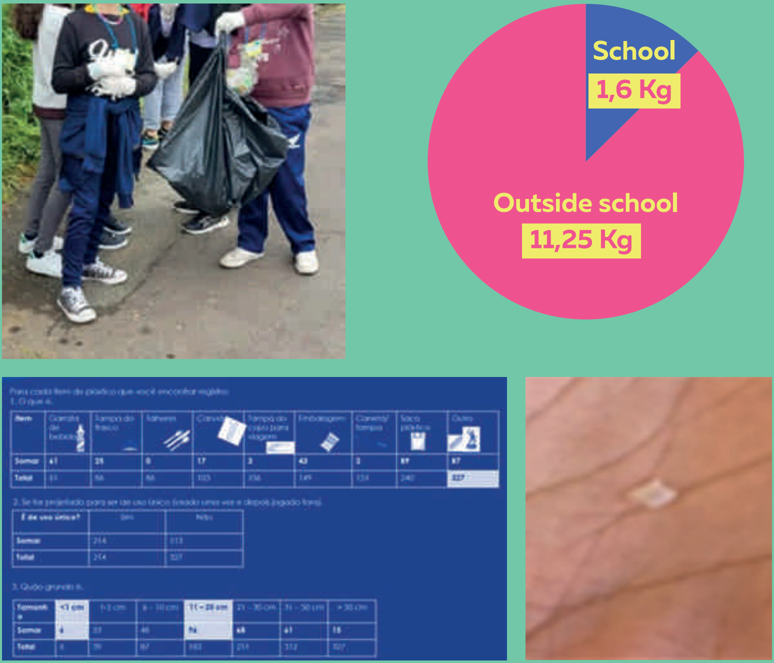
CARE: After completing the Science Action about (micro)plastics, many students (83%) agreed that learning science will be useful in their daily lives and agree that science helps people.

KNOW: Almost half of students feel confident with their knowledge in science (54%) and in using science to come up with questions and ideas (55%).

DO: Almost half of the numbers of students felt confident doing science projects (55%) and less than a half felt able to talk about science (45%).

This data shows that students see the importance of science but more needs to be done to improve their confidence in their science knowledge and skills.

Photos P1: (Micro) Plastic data collection and analysis in Romanian Schools supported by VUT.



Photos P2: (Micro) Plastic data collection and analysis in Brazilian schools led by PUC-PR – Prapetec.

Photos P3: (Micro) Plastic data collection and analysis in Greek schools supported by RDE.

Students' reflective evaluation principles

The CONNECT-Science instrument was designed to promote students' reflection on their relationship with science in their personal lives, society, and their learning experience in open schooling. It draws upon the concepts of science capital (Archer et. al., 2015) and affective engagement with science (Ben et. al., 2018, Archer et. al., 2015; Dewitt et. al., 2016), serving as a facilitator for this reflective process. The instrument consists of six factors that have been tailored to suit the context of open schooling and align with the CARE-KNOW-DO framework. Table 1 illustrates the foundation of the framework, showcasing the four dimensions of science capital and two dimensions of affective engagement.

	Dimension (Archers)	Factors lacking	CARE-KNOW-DO framework (adapts and extends science capital dimensions)
science capital	**D2. How youth think about science**	Students often see little relevance in science in general, which appears abstract	Scenarios with real-life issues are selected by young people with STEM professionals and families that they **CARE** about. Through designing actions, learners can take themselves, they will see the connection between science and what they can do with it locally, thus attaching greater value to *"Science is for me"*
	D4. What youth know about science	Students have limited concept of science careers	Students are guided to **KNOW** how STEM professionals use science content and skills to solve problems in diverse areas and become aware of its transferability to a wide range of career pathways. *"I know science"*
	D3. Who youth know to discuss science	Low science capital students have rarely had contact with scientists	STEM professionals and/or family members mentor and inspire students in the **KNOW** stage: to support them in the process of applying scientific ideas to come to informed views, take thoughtful actions, and make considered decisions. *"I can talk about science"*
	D1. What youth do about science	Students rarely talk about science with their family members	Science is more visible and talked about, as family members get involved in discussing the issues, supporting students in the **DO** stage as they create scenario-action activities. *"I can do science"*
Affective engagement	**D5. What youth feel about science they learned**	Students lack confidence and interest with fun in learning science	Engages students with real scenarios and fun participatory methods for them to **ENJOY** science in and outside school supported by professional experts, community and family members and their intrinsic motivation. *"I enjoy science"*
	D6. How youth think they learn science	Students have little experience of steering their learning and lack an active role	Scaffolds learning processes to foster students' capabilities with an active role for them to **LEARN** science collaboratively supported by others (scientists and families) and independently based on their own initiatives *"I can learn science"*.

Table 1. Science Capital dimensions and affective learning to enhance the CARE-KNOW-DO theoretical frame, methods and analysis (Okada 2017).

The CONNECT-SCIENCE questionnaire was validated in 5 countries and presented in 5 languages.

1. HOW OFTEN DO YOU DO THESE ACTIVITIES OUTSIDE SCHOOL?

(1. Never – 5. Always)
D1.1. I do science activities outside school (e.g., neighbourhood, park, at home).
D1.2. I search for extra information related to science activities at home.
D1.3. I read about science at home (web, news, books).
D1.4. I talk about real-life problems to learn science.
D1.5. I ask interesting questions to learn science.

2. WHAT ARE YOUR VIEWS ABOUT SCIENCE IN THE WORLD?

(1. Totally disagree -5. Totally Agree)
D2.1. Science helps people around the world to lead pleasant, healthy lives.
D2.2. Science, technology, and maths are important for solving problems.
D2.3. Scientists need to use their imagination to solve problems.
D2.4. Scientists usually work alone.
D2.5. Knowing science helps people to make decisions using information.
D2.6. Learning science will be useful in my daily life.

3. WHAT ARE YOUR VIEWS ABOUT SCIENCE IN YOUR FUTURE?

D3.1. I know some people working with science to talk about what their jobs are like.
D3.2. Science knowledge and skills will help me to get a job.
D3.3. My family thinks science is interesting.
D3.4. My family thinks science will be important for my future.
D3.5. My teachers have explained the importance of science in my life and society.
D3.6. My teacher encourages me to keep learning science.

4. HOW CONFIDENT ARE YOU WITH SCIENCE?

D4.1. I feel confident doing science projects with other people.
D4.2. I feel confident talking about science.
D4.3. I feel confident using science to come up with questions and ideas.
D4.4. I feel confident using maths to solve problems in science.
D4.5. I feel confident with my knowledge in science.
D4.6. I know how to justify my views using arguments and evidence (facts or data).

5. HOW DO YOU LEARN SCIENCE?

D5.1. Learning science is about memorising terms and equations.
D5.2. Getting the correct answer is more important than knowing how you got it.
D5.3. Students should try to solve problems themselves first before asking how to solve it.
D5.4. Not all scientific questions have clear answers.
D5.5. Discussions with my teacher and students help me understand science.
D5.6. Students should have opportunities to learn science with others (scientists, families).

6. HOW DO YOU FEEL ABOUT SCIENCE?

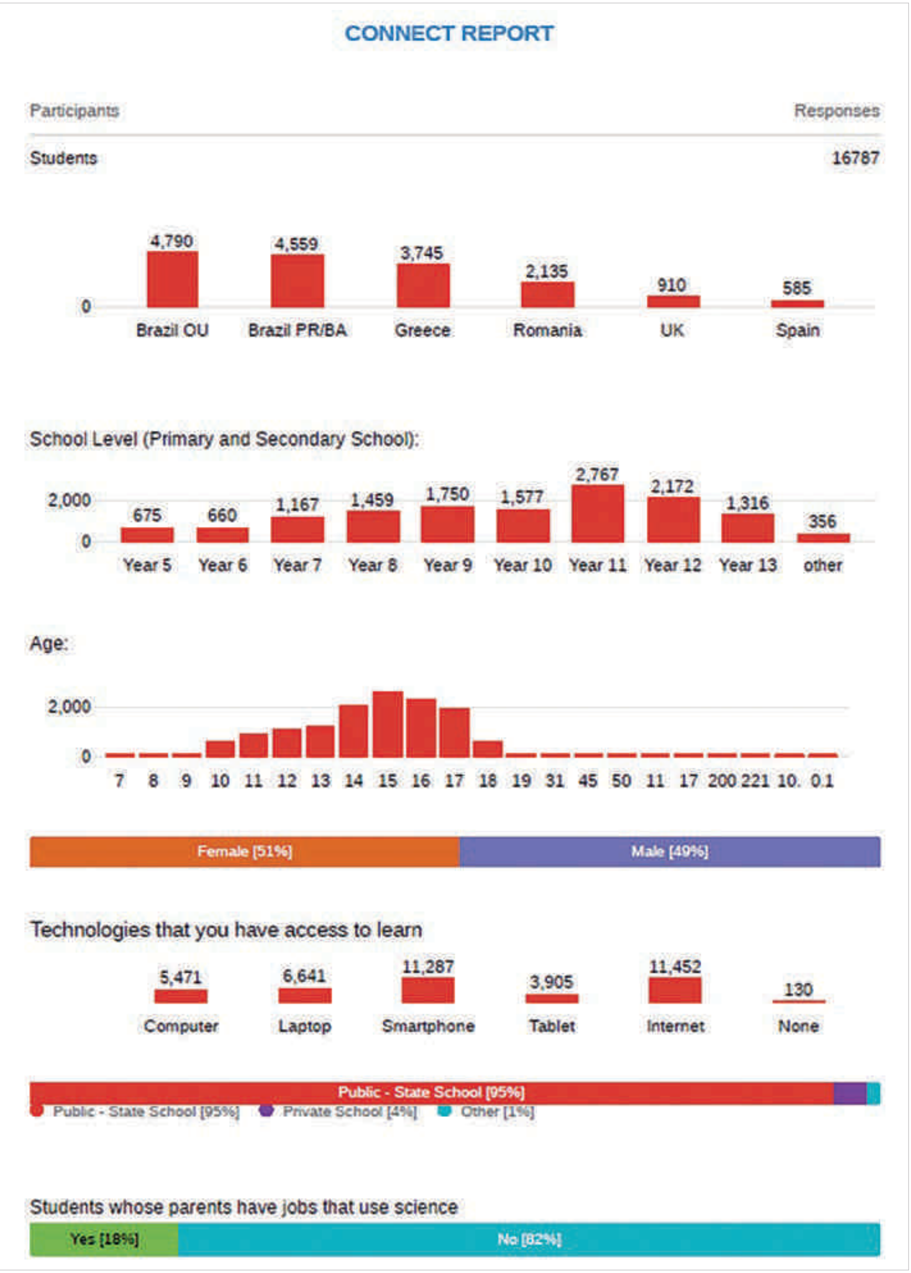
D6.1. Learning science is enjoyable for me.
D6.2. Science activities are fun.
D6.3. Learning science is easy.
D6.4. I would like to do projects with others using science to improve the world.
D6.5. I would like to be seen as an expert in science.
D6.6. I would like a job that uses science.

The instrument was also combined with open questions for students to describe about their science-actions, and learning experience with their families, communities, science professionals, academics, or scientists, and to share comments and questions.

Students' transformation: science connection!

A total of 16787 students aged between 7 and 19 completed their open schooling projects and the CONNECT-SCIENCE questionnaire on a voluntary basis. They were learners from all grade levels in primary, secondary, and tertiary education. As addressing our mission focused on underserved students:

Most students were at a state school (95%) - some of which would be from lower socioeconomic backgrounds. Only 17% had parents in jobs that use science, meaning they are less likely to engage with science at home. Many students have access to a mobile phone with internet (68%), but 130 do not have access to a computer, tablet, or laptop at home.



CONNECT REPORT

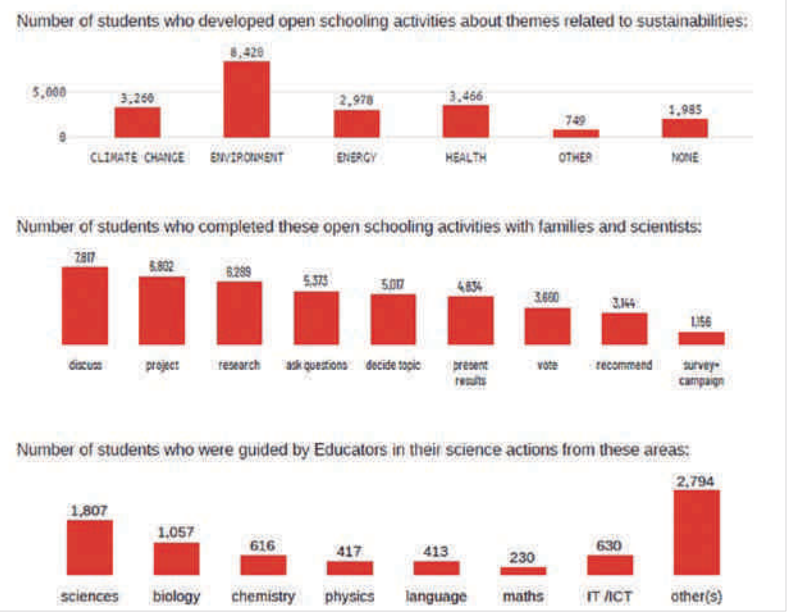
Participants	Responses
Students	16787

Graphs S1: Students' views about science in their lives – demographics.

Students' science actions

The CARE-KNOW-DO pedagogy encourages students to identify real-world problems that matter to them. The majority (70%) of open schooling activities developed by the students were focused on green issues - climate change and the environment. This highlights how important these issues are to young people and shows a need to increase sustainability education within the curriculum. Other important issues that they were interested in were health and energy.

A variety of open schooling activities were used, the most popular being discussion, completing a project, carrying out research and asking questions - all important scientific thinking skills and those that are needed by students aspiring to scientific careers. We saw a wide range of educators, other than scientists, involved in helping students, especially from the fields of geography and art. Many students mentioned agroindustry, farming, agriculture, and professionals. This may help to inspire students to have scientific careers in fields that they may not have considered, especially those that live in rural communities.


Number of students who developed open schooling activities about themes related to sustainabilities:

Number of students who completed these open schooling activities with families and scientists:

Number of students who were guided by Educators in their science actions from these areas:

Graphs S2: Students' views about science in their lives – activities.

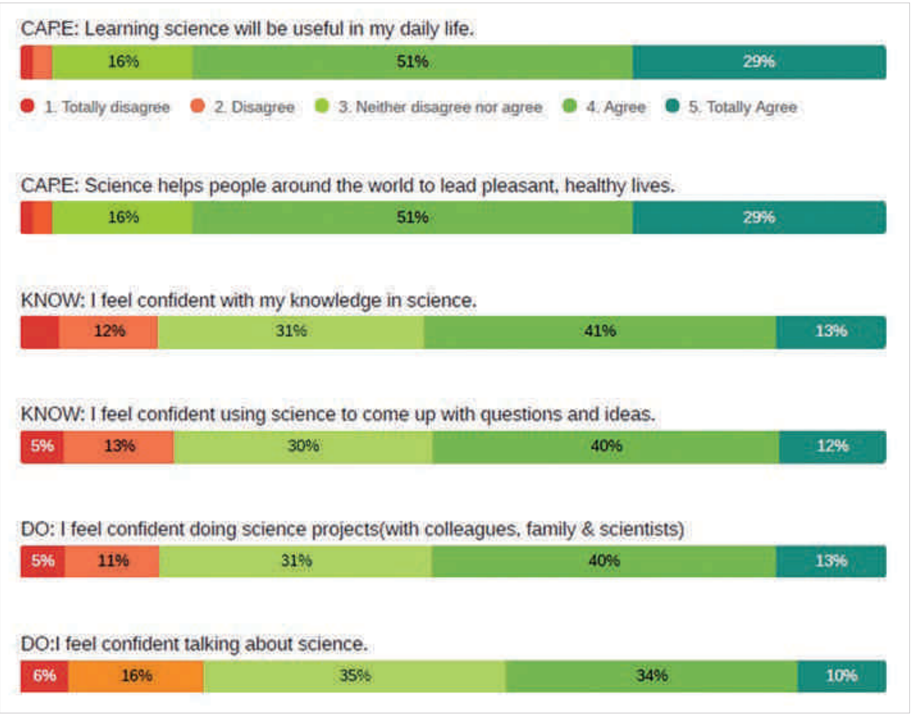
CARE- KNOW-DO

CARE:
After completing a Science Action, the majority of students (80%) agreed that learning science will be useful in their daily lives and science helps people.

KNOW:
Just over half of students feel confident with their knowledge in science (54%) and in using science to come up with questions and ideas (52%).

DO:
Around half of students felt confident doing science projects (53%) but less than a half felt able to talk about science (44%).

This data shows that students see the importance of science but more needs to be done to improve their confidence in their science knowledge and skills.

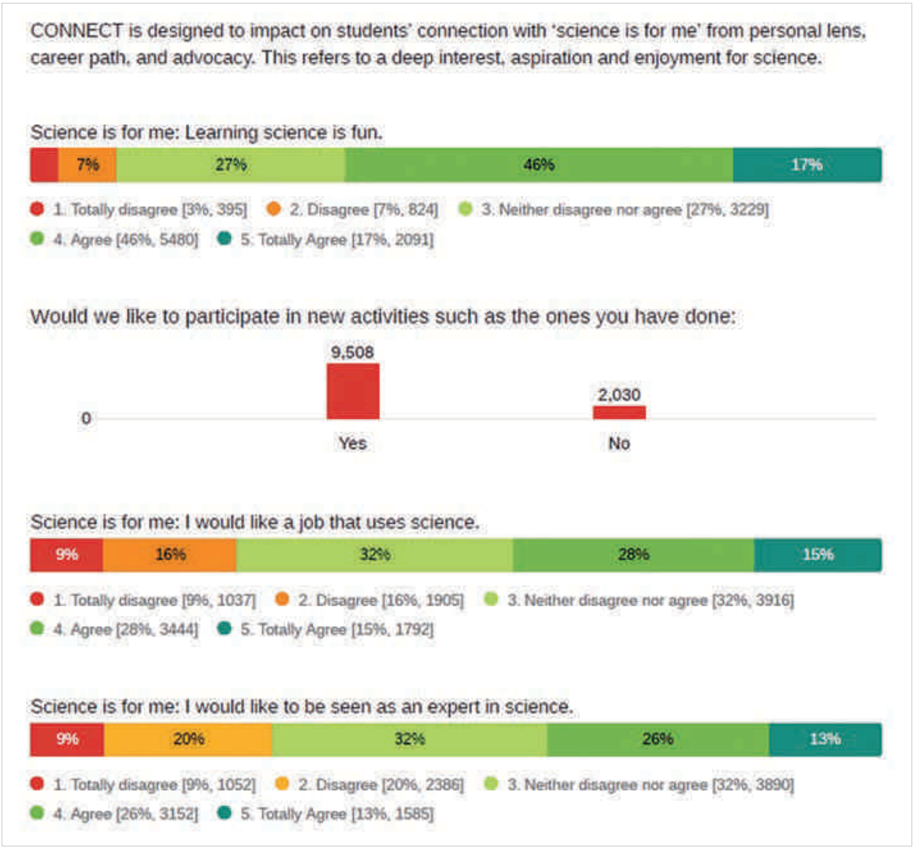


Graphs S3: Students' views about science in their lives – CARE-KNOW-DO.

Affective engagement

Affective engagement in learning refers to the emotional and attitudinal involvement of learners in the learning process. It focuses on the emotional connection, interest, and enjoyment that learners experience while engaging with educational activities. In CONNECT, affective engagement encompasses feelings of curiosity, motivation, enthusiasm, and a sense of personal relevance and value of science learning in their lives. It involves developing a positive attitude towards learning, being emotionally invested in the subject matter, and experiencing a sense of satisfaction and fulfilment from the learning process. Affective engagement plays a crucial role in fostering intrinsic motivation, promoting deep learning, and enhancing overall learning outcomes.

63% said that learning science is fun, with 82% expressing an interest in completing more similar science activities. 43% of students said they would like a job in science, with 39% saying they would like to be seen as a science expert. A further 32% were not sure. Further work could be done on persuading students to pursue a scientific career. An output of an increased science capital is thinking that ‘science is for me’.

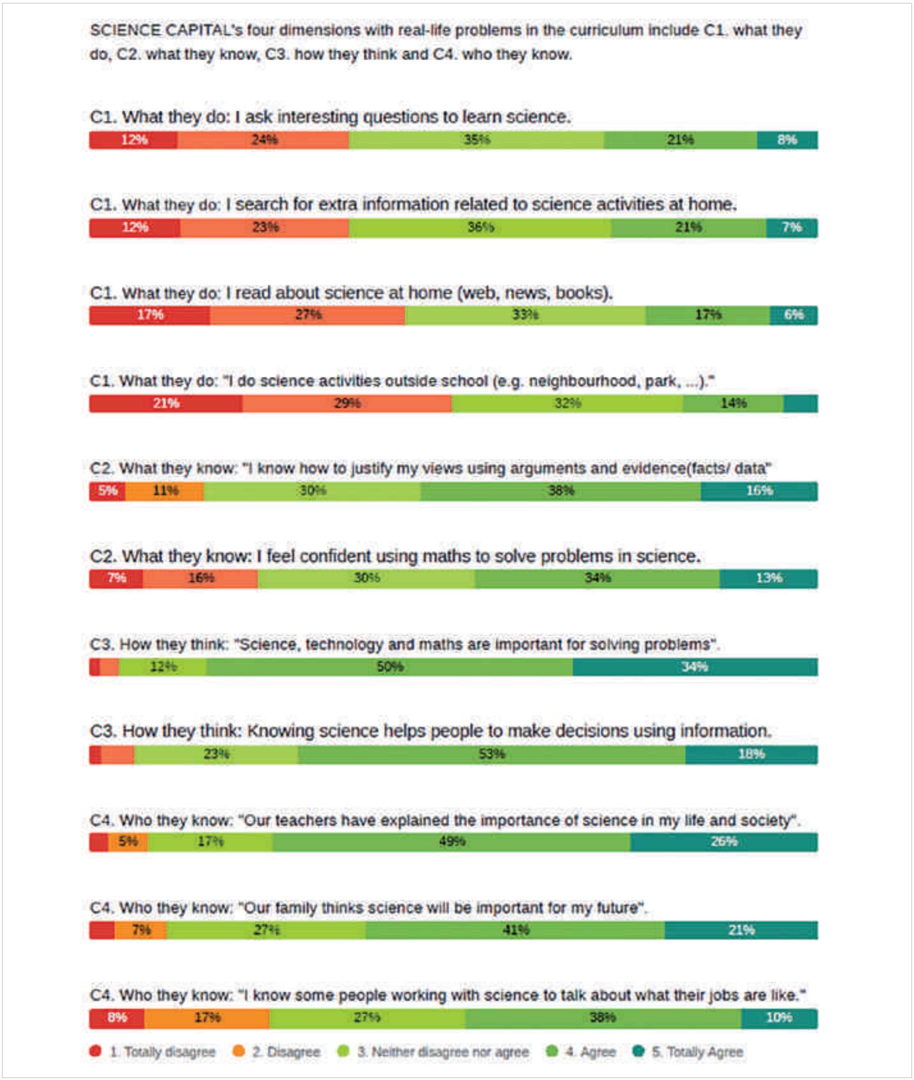


CONNECT is designed to impact on students' connection with 'science is for me' from personal lens, career path, and advocacy. This refers to a deep interest, aspiration and enjoyment for science.

Graphs S4: Students' views about 'is science for them'.

Underserved students' science capital

Using the questionnaire, the students self-assessed four components of science capital – what they do, what they know, how they think, who they know.



Graphs S5: Students' views related to science capital – indicators.

What they do with science outside school:

This component saw the lowest student engagement. Some students (29%) ask interesting questions to learn science, with 28% searching for extra information at home, just 23% reading about science and only 18% doing science activities outside of school. This highlights the need for more work to be done on improving student engagement with science outside of formal learning environments.

What they know:

The data generated more positive results, with students feeling confident in how to justify their views (54%) and using maths to solve problems in science (47%). However, 30% of students in each case were unsure. This highlights the fact that with further intervention, these students could be helped to become more confident. This is the area where further work could make a difference.

How they think:

The majority of students see the value in science. 84% think that science is important for solving problems and 75% think that knowing science helps people to make decisions.

Who they know:

After completing a Science Action, most students reported that their teachers explain the importance of science (75%) and their family think science is important for the future (62%). 48% of students know someone working with science. As only 18% have parents who work in science, **this highlights the positive impact the project had on their interaction with scientists.**

Differences across countries, group ages and gender

There were three countries who implemented open schooling with many students in upper secondary school and implemented in low secondary and primary school as well, these countries were Brazil, Greece, and Romania. Our findings show that the affective engagement and science capital of younger students were slightly higher than older students. This suggests that students' connection with science decreased as students got older. Our findings in four countries also indicate that younger students are more connected to science in their lives and society; they are more keen on a career in science and be seen as an expert in science than older students. Consistently, for one of the countries whose older students were more connected to science, they also presented higher science capital and affective engagement.

Although CONNECT open schooling activities were equally disseminated across all levels of secondary schools; our findings show there are countries who found much more difficult to implement open schooling with older students due to the teachers' pressure and focus with national curriculum content, in particular, for students in their transition from school to higher education. In the UK and Spain, teachers in the primary and low secondary schools were more involved in applying open schooling activities and could complete and generating evaluation data with various students. This was expected as the curriculum for older students focused on exams.

There are differences among the results between both countries. In the UK, young students are more confident in science with a positive perception of families' value of science in their future and more connected to science is for them in comparison to older students. Conversely, In Spain, older students found science more relevant in their lives, they also feel more confident with science knowledge and justifying their views using arguments.in addition they think that their parents consider science important for their future. These findings from both countries are consistently with science capital and affective engagement theory which were the basis of our CONNECT-science instrument. The more knowledge, peoples' encouragement and affective engagement students have for science the more positive connection they will establish and expand about science in their lives now towards the future.

We also discovered differences in confidence in science and attitudes to science between genders. Even though the numbers of males and females who were confident in their knowledge and scientific enquiry skills were roughly equal, more boys reported that they 'totally agreed' with being confident compared to girls. Also, boys were more confident when it came to expressing their ideas verbally.

Slightly more females agreed with the statement 'our family thinks that science will be important for my future' and 'learning science is fun' and agreed that science is useful and helps people. Numbers for both sexes were equal when agreeing with the statements related to wanting a job in science and being seen as an expert in science.

The data shows that students identifying as 'other' reported low confidence in all the aspects of science examined.

Five countries' case studies

The following sections present more details about these geographical differences and theoretical consistencies.

UK

Cohort A was made up of 664 low secondary students aged 11-14, cohort B was 151 upper secondary students aged 15-17.

Low secondary students had a higher proportion of parents who think science is important for their children's future (82%), only some have jobs in science (29%) compared to upper secondary students, with slightly lower number of parents who value science in their children's lives (76%) but very few with jobs in science (15%). There are significant differences in perceived understanding of science between the cohorts. Cohort A were more confident in their science knowledge (A: 51%, B: 39%) and using science to come up with questions and ideas (A: 52%, B: 27%). This may be due to an increase in difficulty of science content as older students will be preparing for their GCSEs.

There was also a difference in attitude to science. More younger students felt that learning science was fun (A: 66%, B: 44%), are more likely to want to pursue a career in science (A: 28%, B: 22%) and would like to be seen as an expert in science (A:31%, B: 15%). This disparity is concerning, as it shows that some students become less interested in science as they progress through school, just as they are deciding what to study at higher education. It could be caused by the types of lessons being used with older students, as the pressure of completing the GCSE curriculum means teachers are more likely to focus solely on teaching content.

Spain

Cohort A was made up of 295 students aged 11-14, cohort B was 86 students aged 15-18. In terms of the importance of science, older students thought that learning science would be useful in their daily life with 83% of cohort B agreeing with this statement, compared to 72% of cohort A. Older students were also more confident in their knowledge (A: 34%, B: 48%), talking about science (A: 33%, B: 40%) and justifying views using arguments (A: 44%, B: 52%). This shows that students feel more confident in their knowledge and skills as they get older.

In terms of attitudes to science, more older students feel that their family thinks science will be important to their future (A: 46%, B: 76%). There were very similar findings when it came to enjoyment of science and if students wanted to pursue a career in science.

Romania

Cohort A was made up of 322 students aged 11-14, cohort B was 1169 students aged 15-18. Responses to understanding of science were very similar across both cohorts, with both having roughly the same levels of confidence. Slightly more younger students agreed that learning science was fun (A: 79%, B: 71%). More older students wanted a job that uses science (A: 32%, B: 40%).

Greece

Cohort A was made up of 422 students aged 9-10. Cohort B was 1556 students aged 11-14 and cohort C was 912 students aged 15-18. Responses to both knowledge and attitudes to science were slightly higher for young students in all categories than older students in particular comparing the youngest (primary schools with the oldest upper secondary); confidence in knowledge (A:64%; B:58%); family's value of science (A:73%, B:67%) confidence in talking about science (A:50%, B:42%), finding science fun (A:65%, B: 42%), willing a job in science (A:55%, B:48%), willing to be an expert in science (A: 49%, B:37%).

Brazil

Cohort A was made up of 93 students aged 9-10. B was 905 students aged 11-14 and cohort C was 2039 students aged 15-18.

Confidence in all aspects of science decreased as students got older: Knowledge (A:63% B:52% C:49%), using science to come up with questions (A:64% B:55% C:51%), doing science projects (A:56% B:63% C:50%), talking about science (A:56% B:50% C:38%) and justifying views using arguments and evidence (A:59% B:66% C:53%). This is similar to the findings in the UK.

Enjoyment in science also decreased with age, with fewer students responding positively to the statement: learning science is fun (A:73% B:69% C:64%). Younger students were more keen on a career in science (A:59% B:48% C:47%).

Out of a total of 11,954 students who filled in a questionnaire 49% identified as female, 49% as male and 2% as other.

Slightly more females agreed with the statement that learning science will be useful in my daily life and that science helps people (F:82% M:79% O:65%). This is an indication of why females are more likely to pursue scientific careers related to life and health sciences (those more generally seen as helping people), rather than careers in physics, engineering, and maths.

Both males and females were equally as confident when it came to their knowledge in science, using science to come up with questions and doing science projects. It should be noted, however, that in all these contexts, more males than females reported totally agreeing with the statement, indicating a higher confidence. Males were also more confident talking about science (F:42% M:55% O:37%). The data shows that males are more confident in science lessons, when expressing their views verbally. It would be interesting to see if this trend is seen in single sex schools compared to mixed schools.

The data shows that students identifying as 'other' reported low confidence in all the aspects of science examined.

Slightly more females agreed with the statement 'our family thinks that science will be important for my future' (F:64% M:61% O:41%) and 'learning science is fun (F:65% M:61% O:56%). Numbers for both sexes were equal when agreeing with the statements related to wanting a job in science and being seen as an expert in science. This is very encouraging, as it shows that females are just as likely to want to pursue a career in science as their male counterparts. The numbers for all these questions were lower for students who identify as other, highlighting the need for showing inclusivity in science careers within lessons.

Teachers' reflective instrument principles

The OU designed a self-reported research instrument for teachers to evaluate pedagogical components and teaching strategies that support open schooling which involves connecting students with real-life problems that they care about, science that they need to know and actions that they can do towards solutions supported by scientists and families including community members. This instrument was refined and validated with the input of more than a thousand teachers who responded to the questionnaire and 884 responses were completed from Greece, Romania, Spain, the UK and Brazil. Data generated enables assessing the effectiveness of teaching methods employed in open schooling. The instrument underpinned by the work of Mary Ratcliffe "science education for responsible citizenship" has a five-dimensional model with 3 categories in the context of open schooling. These are novice and advanced, and expert teachers (Okada, 2023). The pedagogy of science education principles towards fostering young people as independent thinkers was embedded to examine the challenges for teachers in the process to empower students and shift from passive receptors of information to emancipated active learners capable of using science to transform their lives and their local communities.

This model facilitates teacher reflection on pedagogical enhancements with coaching support and resources. (See table 2).

Dimensions needed to transform practices	Novice Teachers	Advanced Teachers	Open Schooling Expert teachers
D1. Teachers' knowledge and understanding of nature of science (NOS)	Anxious about their understanding of NOS	Confident that they have sufficient understanding of NOS	Expert about NOS and science with and for society
D2. Teachers' conception of their own role	Dispenser of knowledge	Facilitator of learning	'knowledge broker' between students and scientists within society
D3. Teachers' use of discourse	Closed and authoritative	Open and dialogic	Engaging and Scientific for scaffolding students' evidence-based dialogue
D4. Teachers' conception of learning goals	Limited to knowledge gains	Includes the development of reasoning skills	Enhances students' science knowledge, skills, attitude, and values (competences & science capital)
D5. The nature of classroom activities	Students' activities are contrived and inauthentic	Activities are owned by students and are authentic	Activities enhances students 'science-actions' with real world issues

Table 2: Five-dimension-model to transform teaching practices in the context of open schooling pedagogical knowledge Okada 2021.

Our instrument was designed using the five dimensions.

1. HOW CONFIDENT DO YOU FEEL WITH THESE TEACHING PRACTICES?

(1.very little confident to very confident)

1. teach scientific inquiry with real-life problems.
2. promote discussion about science in society in the classroom.
3. help students generate questions with evidence-based views.
4. promote science learning activities beyond school curriculum.
5. support students' interaction with researchers and scientists.
6. encourage students to discuss science topics with family members.
7. use questions to trigger divergent modes of thinking and argumentation.
8. enable students to engage in small group discussions.
9. assess how well students use evidence to form an argument.
10. establish learning goals supported by free digital resources in the curriculum.
11. discuss with students the learning goals that include scientists.
12. help students to air their views and listen carefully to others in group discussions.
13. arouse students' curiosity to undertake problem-solving with intrinsic motivation.
14. guide students to search for reliable resources and sources of information.
15. provide students' fun activities that have relevance to their everyday lives.

2. FOR EACH OF THE STRATEGIES, PLEASE RATE THE FREQUENCY OF USE IN YOUR LESSONS:

(1. Never to 5. Always)

1. teacher explaining ideas.
2. teacher demonstrations.
3. students using textbooks.
4. students talking about topical scientific issues.
5. students discussing in small groups.
6. students participating in whole class discussion.
7. students raising issues for discussion about the topic.
8. students develop collaborative inquiry project.
9. students using collaborative games/ role play.
(Other strategy)

3. DID YOU USE ANY OF THESE TASKS FOR STUDENTS TO SOLVE REAL-LIFE PROBLEMS:

1.discussion, 2. deciding a topic, 3. formulating questions, 4. voting, 5. research, 6. developing a project, 7. creating recommendations, 8. presenting results, 9. other.

4. THE FOLLOWING QUESTIONS FOCUS ON YOUR VIEWS ABOUT OPEN SCHOOLING.

- Have you taught science using a real-life problem?
- Were families involved in the activities? Please provide the benefits about the involvement of families (e.g. activities, benefits or obstacles).
- Were scientists involved in the activities? Please provide the benefits about the involvement of scientists (e.g. activities, benefits or obstacles).
- Could you describe any example of good student practice solving real-life problems? what would be/were their achievements?
- What is the degree of students' involvement in the implementation of a solution related to real-life problems? Describe in a few words.
- What are students' outcomes in terms of knowledge and skills? Please describe.
- What are the learning difficulties for your students? e.g. not enough time.
- How well can authentic-science resources meet your needs?
  Note: Please tell us how well they fit with the school curriculum?
- Which activities can work well with the curriculum?
  Note: Please tell us about anything that could be done differently or avoided.
- Would you like to participate in new activities about authentic science?
  Do you have any questions or comments? (optional)

Teachers' transformation: emancipatory lessons

A total of 1392 teachers (above our expected target) from 5 countries implemented the open schooling activities and completed teacher questionnaires. There were a representative number of teachers from STEM, Languages and other areas of Social Science and cross-disciplinary fields of rural school curriculum (farming, agriculture, agribusiness, among others). There were educators from all grade levels covering primary, secondary and tertiary education, including teachers' educators and teaching' coaches.

In terms of gender, 73% of teachers were female. Despite having a significant presence in the teaching profession, many women may not choose to pursue science-related careers due to various factors such as societal stereotypes, lack of role models, and limited opportunities for advancement.

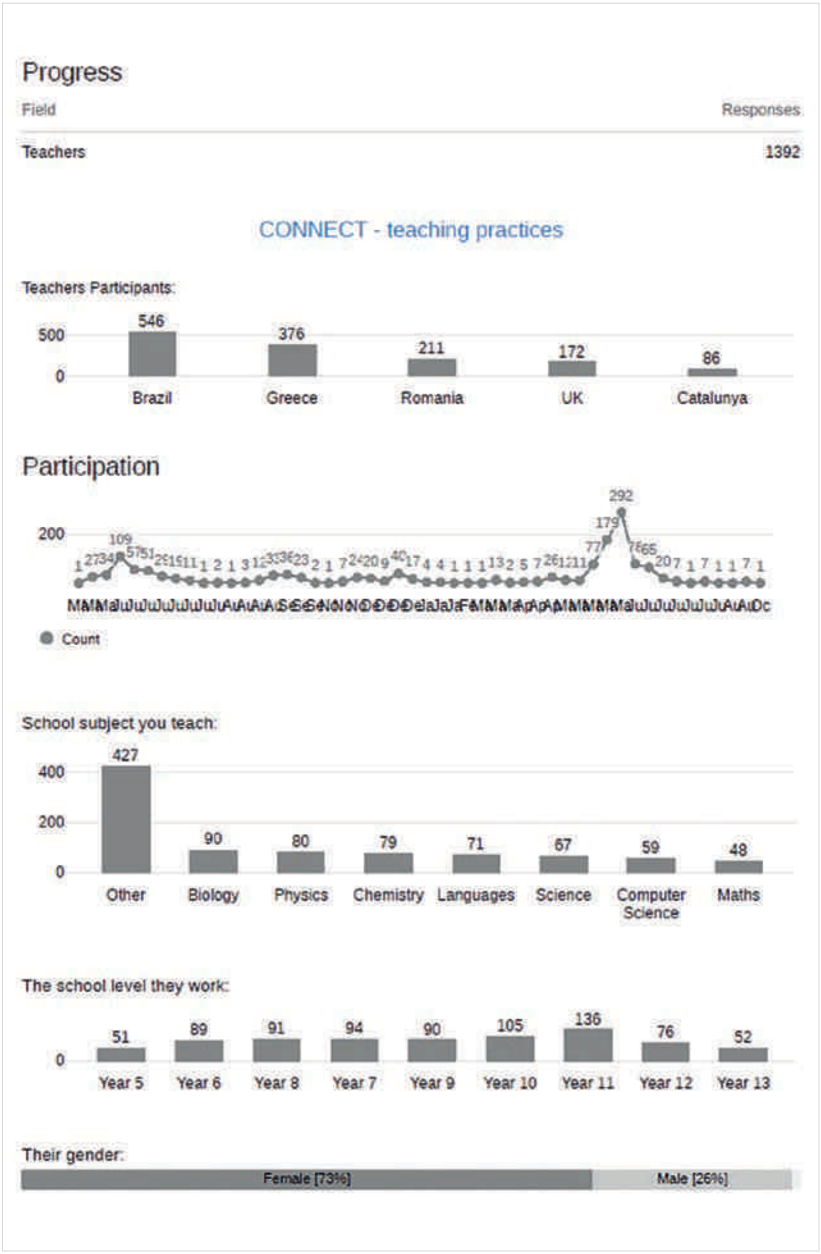
Teachers were asked how confident they were with various aspects of open schooling activities. The areas that teacher confidence was lowest with open schooling activities were promoting science learning activities beyond school curriculum (30%) and discussing with students the learning goals that includes scientists (31%).

"An educational and encouraging activity for both students and teachers and parents with direct involvement and professional support, a teamwork that provided all the necessary resources and additional guidance for the realization of the activities and the transmission of new scientific notions and contents in the debates and online sessions."
Romanian Teacher

"The activity becomes motivating not only for me as a teacher, but also for the students by developing their ability to collaborate with others when tackling a problem and formulating solutions."
Romanian Teacher

"I congratulate your initiative and all the work and support given to everyone to raise awareness of the impact of all the factors involved and to carry out other activities that require multi-level involvement and educational awareness of the importance of the project."
Romanian Families

"I learned the importance of science in everyday life. I learned useful things about white pollution.
That we need to take care of nature.
We learned to protect the environment and how we prevent pollution.
Science helps us live a better life."
Romanian Students



Progress

Field	Responses
Teachers	1392

CONNECT - teaching practices

Teachers Participants:

500
0
546
Brazil
376
Greece
211
Romania
172
UK
86
Catalunya

Participation

200
292
179
109
77
Count

School subject you teach:

400
200
0
427
Other
90
Biology
80
Physics
79
Chemistry
71
Languages
67
Science
59
Computer Science
48
Maths

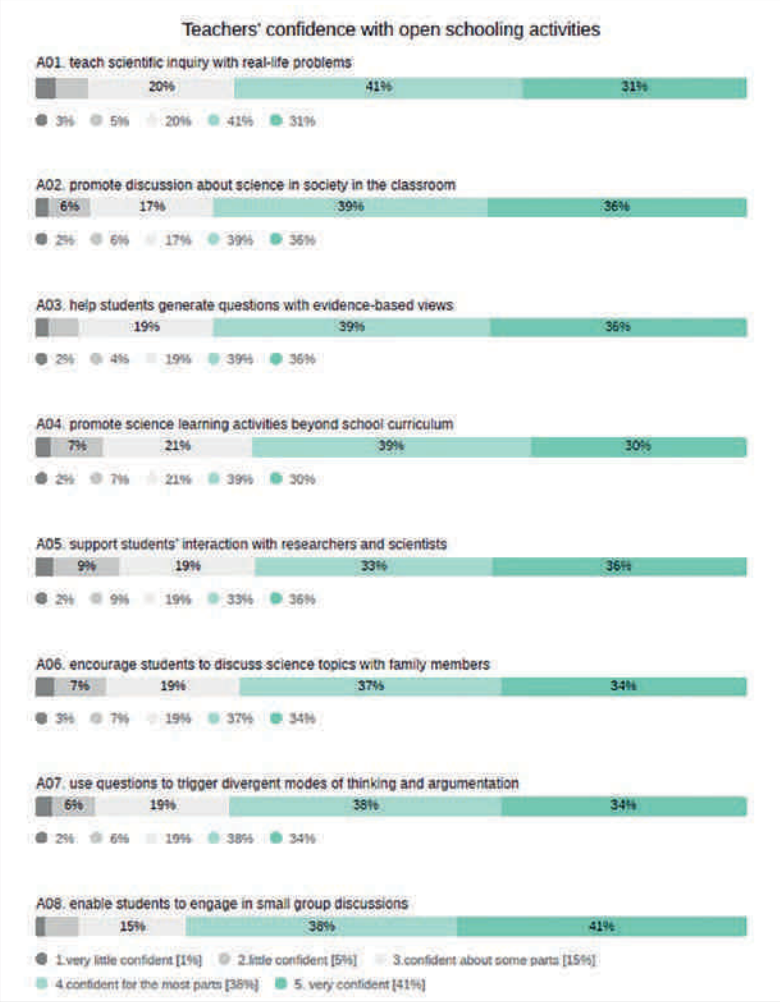
The school level they work:

0
51
Year 5
89
Year 6
91
Year 8
94
Year 7
90
Year 9
105
Year 10
136
Year 11
76
Year 12
52
Year 13

Their gender:

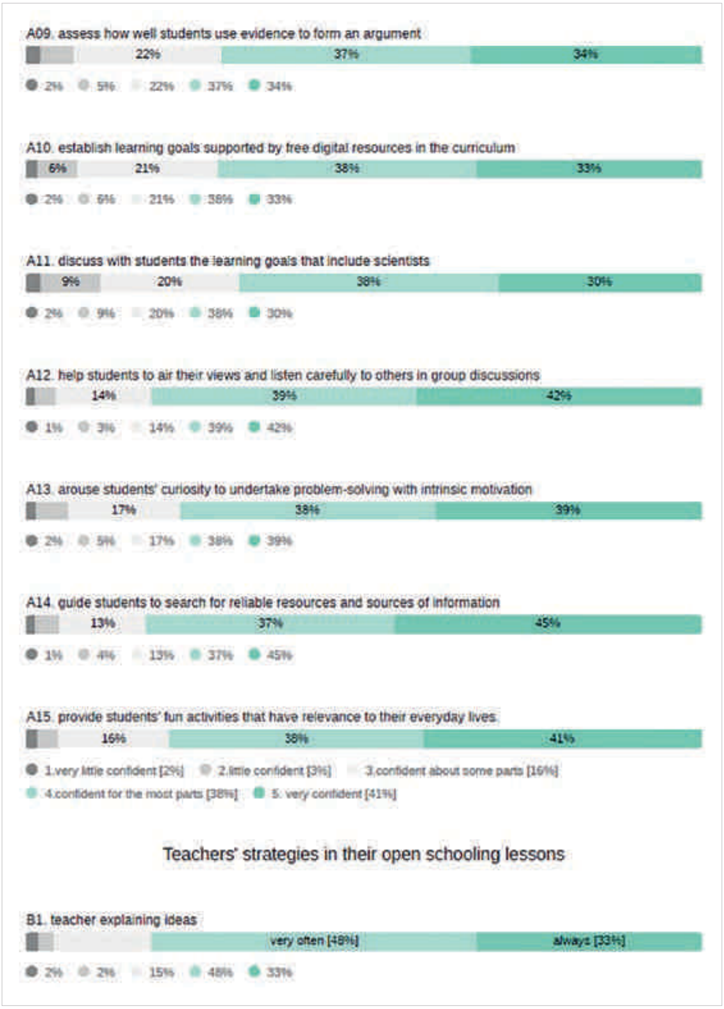
Female [73%]
Male [26%]

Graphs T1: Teachers' views about open schooling – demographics.



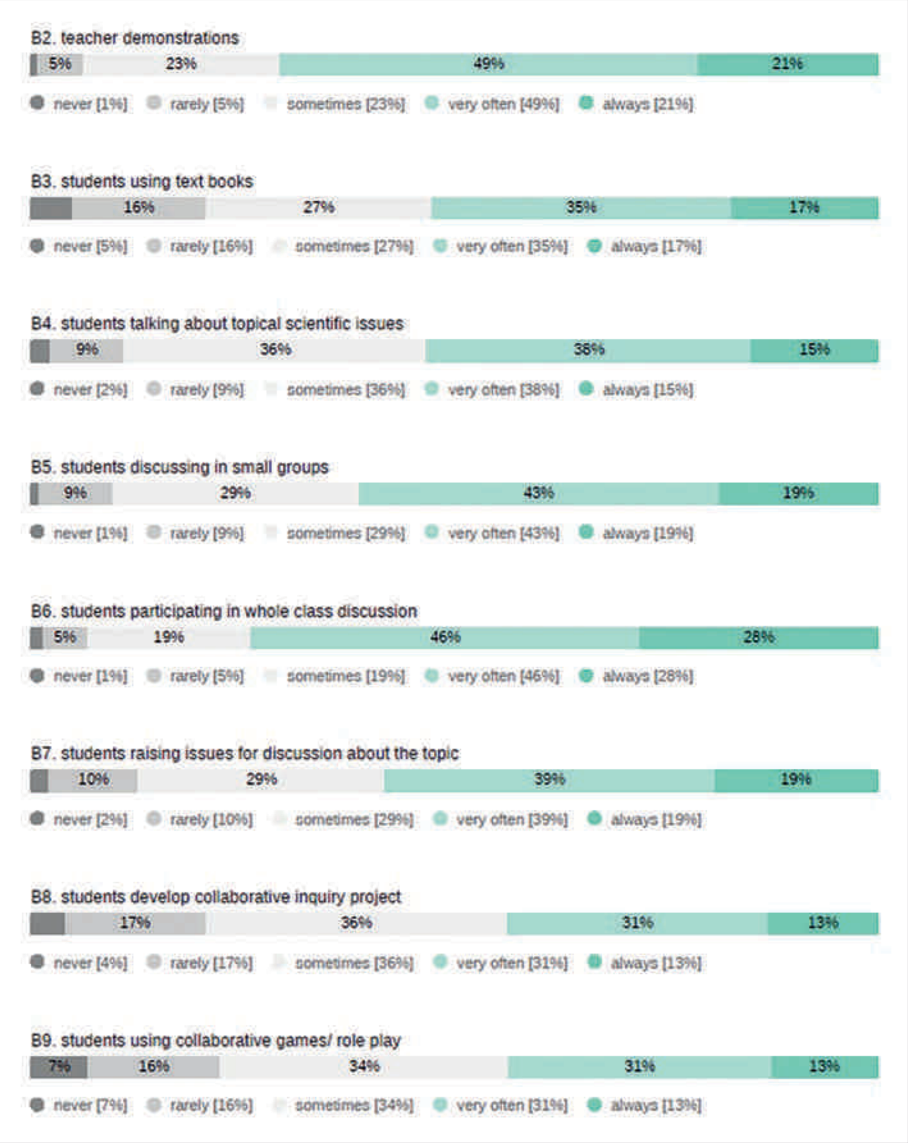
Graphs T2: Teachers' views about open schooling – practices.

The areas they were most confident in were:
Helping students use questions to trigger divergent nodes and thinking and argumentation (72% confident or very confident), promote discussion about science in society in the classroom (75%), generate questions with evidence-based views (75%), engage in small group discussions (79%), air their views in group discussions (81%), and search for reliable resources (82%).



Graphs T3: Teachers' views about open schooling – strategies.

When it came to what strategies teachers used in their lessons, we asked about a variety of methods - some of which are more conducive to open schooling than others. The most popular techniques used by teachers were teacher explaining ideas (81% being used very often or always), demonstrations (70%) and whole class discussions (74%). This highlights the fact that many teachers are novices when it comes to open schooling as they are using didactic teaching methods rather than fostering open discussions.



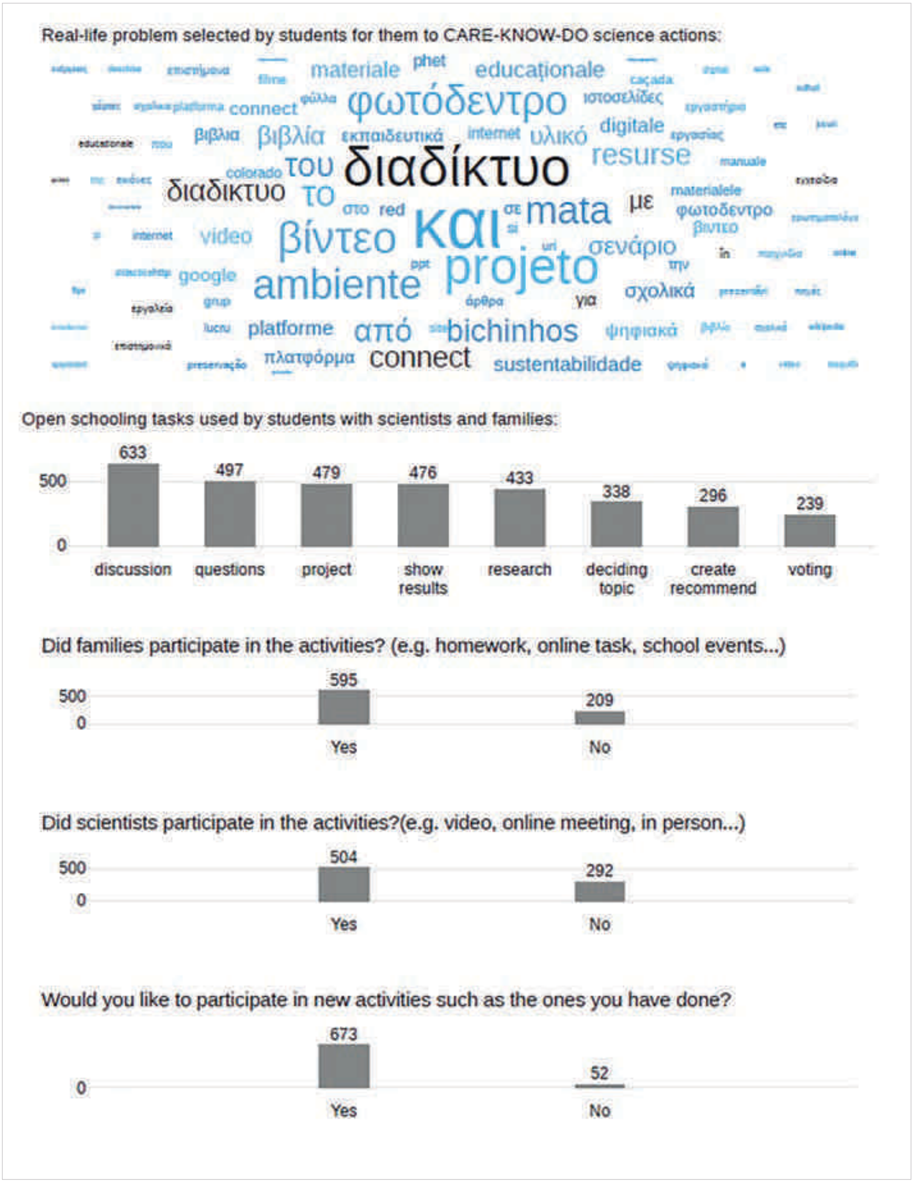
Graphs T4: Teachers' views about open schooling – strategies.

The least popular techniques useful in open schooling included students talking about topical scientific issues (53%), students raising issues for discussion (58%), students developing collaborative inquiry projects (44%) and students using collaborative games/role play (44%). This shows that many teachers need further help in developing these open schooling techniques within their classroom. Teachers reported that the real-life problems selected by students in their Science Actions included: sustainability, environment, Earth's resources, and materials.

A range of open schooling tasks used by students included discussion, asking questions, showing results, carrying out a project, and doing research.

Many families participated in the activities (74%) and various scientists too (63%). For those teachers who did not have the opportunity to get scientists to interact with students on specific dates (37%) they had access to scientists who were especially interviewed for CONNECT. Most teachers reported that they would like to participate in more Science Actions (93%).

Teachers also reported that open schooling activities most used by students with scientists and families were discussion, questions, show/present results projects, and researcher. The activities to be further encouraged as were used only by a few teachers were deciding a topic, create recommendation, and voting.


Real-life problem selected by students for them to CARE-KNOW-DO science actions:

Open schooling tasks used by students with scientists and families:

Did families participate in the activities? (e.g. homework, online task, school events...)

Did scientists participate in the activities?(e.g. video, online meeting, in person...)

Would you like to participate in new activities such as the ones you have done?

Graphs T5: Teachers' views about open schooling – strategies.

Our findings from qualitative data

Dimension-1: Nature of Science (NOS) plays a crucial role in scientific literacy, aiding students in comprehending scientific concepts and cultivating skills for constructing scientific explanations. NOS also helps students acquire knowledge about science and its relationship with society, empowering them to make informed decisions regarding personal and societal matters.

In CONNECT, findings from this dimension revealed that 72% of participating teachers felt confident in teaching scientific inquiry with real problems. Additionally, 75% felt confident in promoting discussions about science in society, and 75% felt confident in assisting students in generating evidence-based questions. Qualitative data from the questionnaire highlighted the teacher's views.

> *"At first some [students] were distracted and some took a little longer, but teams helped as well as the implementation of the theme in the real world gave more motivation."*
> *(Teacher 87)*
>
> *"The students asked questions, studied material, discussed with their families and scientists, and formulated suggestions."*
> *(Teacher 94)*
>
> *"CONNECT's support through the educational resources including real- contexts provided, which we regularly updated during our bi-weekly feedback meetings, was particularly important and met our needs. They also fit into the school curriculum."*
> *(Teacher 16)*

The majority of teachers are advanced when it comes to this dimension, and expressed how CONNECT supported them in this shift. This highlights the significance of coaching and relevant resources in enhancing teachers' confidence and fostering student engagement.

Dimension-2: Teachers perceive their role as facilitators of learning, aiming to enhance students' active participation.

They utilise discussions and leverage students' ideas to teach new concepts, while promoting interactions with scientists, family, and the community to develop their understanding. Findings from this dimension showed that a significant percentage of teachers (69%) promoted science learning activities beyond the school curriculum. Moreover, 69% of teachers supported students' interaction with researchers and scientists, while 71% encouraged students to discuss science topics with their family members.

This dimension was expressed by the teachers in the following extracts obtained from the questionnaire:

> *"Over time, they [students] became interested because it was something completely different from the standard course and they listened to concepts that were easily understood, but which they had never dealt with before."*
> *(Teacher 5)*
>
> *"Initially, it was not clear to the students why they had to take part in this action. This began to change after meeting with the scientist and when they started training the models on their own."*
> *(Teacher 38)*
>
> *"(...) the fact of their parents' involvement played an important role in the confidence and intensity of the students' efforts. Perhaps it is one of the few times throughout their school career that students have collaborated, helped, and been helped by their parents to achieve a common goal."*
> *(Teacher 86)*

In order to help teachers become experts in this dimension, more support could be given to teachers to help them promote learning activities beyond the school curriculum. There was evidence that some teachers are often using instructional techniques classed as novice, where the teacher is a dispenser, rather than facilitator of information. 35% of teachers always explain ideas (rather than allow students to explore them), 25% rely on students using textbooks (rather than a wide range of resources). Only 16% always use topical scientific issues and 20% use small group discussions.

Dimension-3: Teachers prioritise the use of engaging and scientific speech to develop both students' content knowledge and skill sets.

They offer students a choice of topics, address their concerns, and encourage them to define the problem. Through this approach, students are motivated to learn science and explore socio-scientific issues that are personally relevant and foster a genuine desire to acquire knowledge. Teachers in CONNECT also demonstrate a keen understanding of their students' interests and questions. They actively promote reasoned discussions, using questions to stimulate diverse modes of thinking and argumentation, as observed in 77% of the teachers. Additionally, 82% of teachers facilitated small group discussions, allowing students to actively engage with the material. Moreover, 83% of teachers encouraged students to express their views and attentively listen to others during group discussions.

This dimension can be noted in the following extracts from the questionnaire responded to by the teachers:

> *"During the implementation of the program, students did not face any particular difficulties. There was very good cooperation in all groups, very good coordination, all students were consistent in their schedules, they completed all activities with great enthusiasm and the continuous progress of the program was in itself a strong motivation for student engagement."*
> *(Teacher 86)*
>
> *"I think we worked a lot and mainly as a team covering the gaps of classmates or taking over more initiatives – always voluntary."*
> *(Teacher 44)*

To support teachers in this dimension, coaching could be used to help teachers implement meaningful discussion in the classroom.

Dimension-4: Teachers effectively utilise learning goals to foster students' reasoning skills and evidence-based thinking.

These learning goals are clearly defined for both in-school and out-of-school activities, involving scientists and families. The goals are explicitly communicated to students, specifically linked to science topics, and encompass cognitive, affective, and social skills. The activities actively engage students in developing their science knowledge, skills, attitudes, and values, thereby enhancing their competences and science capital. Regarding this dimension, the findings indicated that 71% of teachers established learning goals with the support of free digital resources in the curriculum. Additionally 68% of teachers discussed learning goals with students, which also incorporated the involvement of scientists. Furthermore, 71% of teachers assessed students' ability to utilise evidence in forming an argument. Notwithstanding the majority of the teachers acknowledged positive results, dimension 4 revealed the challenges teachers faced to implement open schooling.

Six major challenging aspects were identified from the teachers' perceptions, as shown in the following extracts:

1. Time pressure

> *"Limited time both in and out of school. On the one hand, the completion of the curriculum is pressing, and on the other hand the extracurricular obligations."*
> *(Teacher 17)*

2. Lack of involvement with the family

"Two students, while they had taken the initiative for interviews with their relatives, did not hand them over. But these were the minority, 2 students out of 22."
(Teacher 8)

"The problems were mainly identified in gathering information from the internet, where many children in grade C found it difficult and delayed to provide the information because their parents did not have the necessary time to help them in this process."
(Teacher 16)

3. Restrictions due to the COVID-19 pandemic

"The last years of the pandemic disrupted students and reduced many students' learning and scientific capital. Many of them showed a significant lack of basic knowledge and scientific thinking. Moreover, the country's deepening economic and social crisis reduced their motivation to learn."
(Teacher 10)

4. Insufficient previous knowledge

"They faced problems in the management of scientific knowledge. This meant that they had difficulty evaluating and thus processing the scientific data they had."
(Teacher 41)

"The students did not have enough basic knowledge as they had not mastered all the steps of teamwork or the project method."
(Teacher 76)

5. Scarce access to technology

> *"The students lacked ICT knowledge. Also, some students did not have access to electronic devices at home (PC, tablet)."*
> *(Teacher 19)*

6. Lack of students motivation

> *"Children get bored easily, all kinds of motivations should be employed especially at the beginning and during the tedious points of research. For example, I didn't give a lecture at all. We went straight into lab use and whatever needed to be said we discussed it when it came up."*
> *(Teacher 54)*

Coaching could help teachers to identify these barriers and find solutions.

Dimension-5: Teachers' shaping the nature of classroom activities to understand science and effective instructional practices.

Teachers promote students to reflect on activity outcomes, guiding them to adopt a common-sense approach for bias elimination and evaluation, while also providing opportunities to address misconceptions. Teachers also facilitate discussions that encourage students to consider multiple perspectives, promoting deep learning and reflection in the field of science.

The activities implemented in this dimension further enhance students' engagement with real-world issues that hold personal relevance. Notably, 77% of teachers in CONNECT successfully stimulate students' curiosity, leading them to undertake problem-solving activities with enthusiasm. Moreover, 82% of teachers skilfully guide students in searching for reliable resources and sources of information, honing their research skills.

Additionally, 79% of teachers design enjoyable activities that connect science to students' everyday lives, fostering a meaningful learning experience.

Some teachers were displaying expert and advanced pedagogical techniques for open schooling, including 22% always asking students to raise issues for discussion, and 14% of teachers always having their students developing collaborative projects. This dimension is observed in the following extracts from the teachers´ questionnaire:

> *"Children who did not have electronic means, contributed to teamwork in other ways, such as finding information from their environment, writing texts, organising group trips to the neighbourhood to collect ideas/data."*
> *(Teacher 19)*
>
> *"They did not encounter any difficulties, as they [the activities] had been simplified enough to be able to participate and carry them through."*
> *(Teacher 58)*
>
> *"The students showed enthusiasm and real/interest for the Project."*
> *(Teacher 31)*

Our findings demonstrate that teachers employed various teaching strategies to actively engage students in real-life socio-scientific problems that were relevant to their lives and communities. To overcome time constraints within specific disciplines, some open schooling initiatives adopted cross-disciplinary approaches, involving teachers from different subjects.

Furthermore, our research revealed that teachers who integrated open schooling activities into the curriculum, involving families, scientists, and student-driven science actions, transitioned from traditional instructional teaching methods to more open-minded semi-instructional approaches. This included teamwork, group discussions, and role-playing.

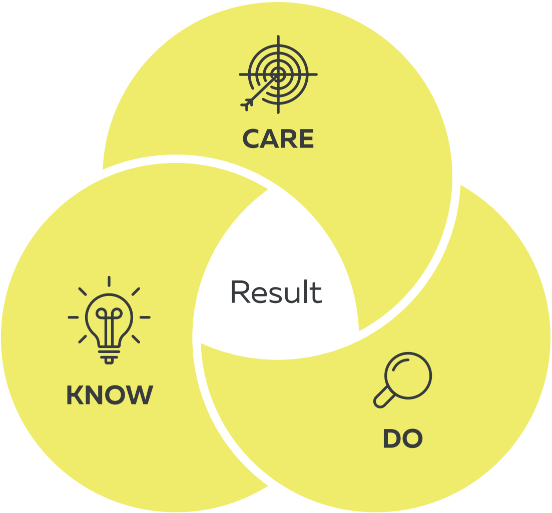
Through the implementation of the flexible coaching model in the CONNECT project, teachers assumed the roles of both research practitioners and learners. This dual role enhanced their understanding of the curriculum and facilitated authentic learning experiences, equipping students to become independent co-learners capable of applying science in their daily lives.

The findings underscored the importance of integrating real-world issues into the curriculum and fostering a strong connection between students and science through innovative pedagogical practices. Peer coaching played a vital role in supporting teacher training and promoting positive outcomes. Additionally, the project highlighted the significance of interdisciplinary learning and the involvement of the broader society in scientific endeavours. The study identified the need for local and national policy support to harness the potential of science and technology for both teachers and students.

This support would enable the showcasing of learning gains and the development of digital scientific literacy skills within a cross-disciplinary curriculum for all students. The integration of the CARE-KNOW-DO approach in the CONNECT program proved particularly valuable, as it emphasised the interplay between purpose-driven curriculum, meaningful learning outcomes, and the interconnected roles of teachers, students, families, and science professionals.

CARE-KNOW-DO Framework

The CARE-KNOW-DO framework is a pedagogical approach that aims to make science education more meaningful, engaging, and relevant for students' (Okada; Sherbone, 2018; Okada, 2020; Okada; Gray, 2023). It emphasizes the importance of students' deep involvement with real-life issues that matters for them, that they care about and encourages authentic learning experiences with and genuine interest. It activates students' affective engagement and to raise the intrinsic motivation necessary for them to develop agency. One of the key features of the CARE-KNOW-DO framework is its focus on collaborative learning. It encourages students to work together with teachers, scientists, and families to explore scientific concepts and take action. By involving various stakeholders, such as policymakers and community members, the framework aims to provide students with a comprehensive understanding of science and its applications in the real world.



I care about the future of the planet as a global ecosystem.

We need knowledge that will help to make changes.

We achieve planetary survival with wisdom in action.

Figure 4: CARE-KNOW-DO.

The framework supports problem-solving and socio-scientific inquiry-based learning. It emphasizes the importance of situating the curriculum in real-life contexts, allowing students to see the relevance of scientific concepts to their own lives and society as a whole. By engaging in problem-solving activities and inquiry-based learning, students develop critical thinking skills and a deeper understanding of scientific processes. It creates an engaging and enjoyable learning experience for students while fostering their knowledge, skills, and attitudes towards science. The framework promotes authentic learning and prepares students to actively participate in their communities and make informed decisions based on scientific evidence through science education connections with real-life issues and involving various stakeholders.

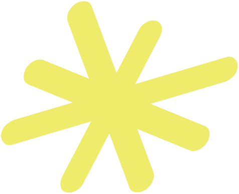
Real-life problems and future-oriented issues play a crucial role in stimulating students' curiosity, fostering intrinsic motivation, and promoting independent thinking with support from others. These relevant problems encourage science professionals and learners to engage in discussions about real-life questions and conduct research to discover innovative solutions. At the same time, they ensure that scientific and technological advancements align with societal needs and values.

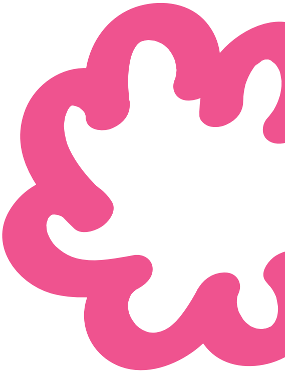
It's important to note that there are other educational frameworks designed for problem-solving. For example, the 5E Instructional Model (Bybee, 1997) consists of five phases: Engage, Explore, Explain, Elaborate, and Evaluate. This model aims to facilitate active learning and inquiry-based teaching in science. The Engage phase captures students' interest and curiosity, while explore encourages hands-on exploration and data gathering. The Explain phase involves presenting concepts and explanations and elaborate extends learning through application and further investigation. Finally, the Evaluate phase assesses students' understanding and learning outcomes.

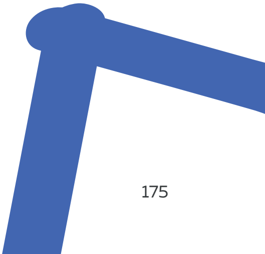
Similarly, the Inquiry-Based Learning framework (NRC, 2000) emphasizes students' active engagement in the inquiry process. It involves asking questions, conducting investigations, gathering evidence, and constructing their own understanding of scientific concepts. This approach emphasizes critical thinking, problem-solving, and the development of scientific skills, empowering students to take ownership of their learning. These frameworks are frequently used to help students gain knowledge of concepts, theories, and processes.

In contrast, the CARE-KNOW-DO framework introduces novel aspects that include personal value connected to the experience ("I care about," "It matters to me") and learning leading to action, such as decision-making and problem-solving. The framework empowers students to reflect, act, intervene, and transform towards better outcomes and more significant results, contributing to shaping a desirable and sustainable future.

Overall, these frameworks serve as valuable tools in education, promoting active learning, problem-solving, and the development of skills necessary for students to make meaningful contributions for their lives and society.





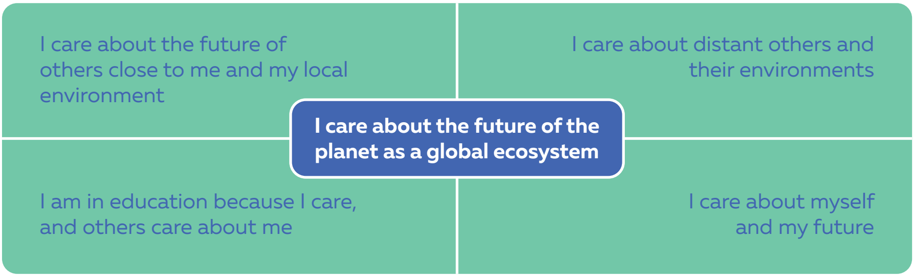


accept challenge
in school with professional
WE
care
raise awareness
at home with family

The concept of CARE encompasses two dimensions. Firstly, it emphasizes the responsibility of looking after the environment and the life forms within it, acting as stewards for future generations. This reflects the understanding that our actions can have long-term consequences and the need to take care of our surroundings (Okada, 2020).

Secondly, CARE also relates to things that have personal value or significance to individuals, such as health, security, and the environment. It extends to the community level, encompassing concerns like eliminating pollution, poverty, and global warming. In this way, CARE encompasses both individual and collective well-being, encouraging students to consider their own needs and the needs of their communities when engaging with real-life challenges.

In open schooling, CARE helps students, in conjunction with experts and society, to develop the ethical values and responsible attitudes that are fundamental to Responsible Research and Innovation (RRI) as described in Figure 6.



I care about the future of others close to me and my local environment

I care about distant others and their environments

I care about the future of the planet as a global ecosystem

I am in education because I care, and others care about me

I care about myself and my future

Figure 5: CARE values for sustainability; Source: Okada & Gray, 2023.

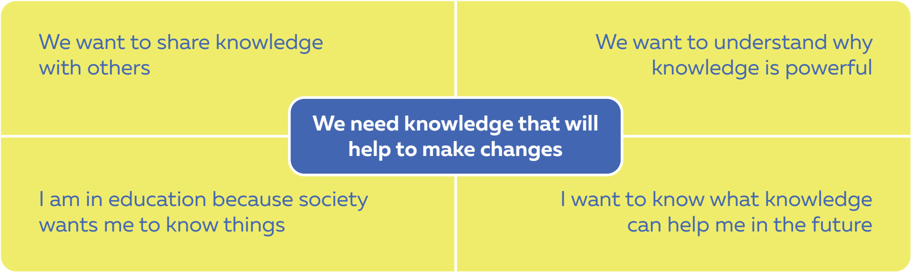
learn concepts & skills

in school

WE know

The “KNOW” component focuses on students’ acquisition of knowledge to understand problems and engage in discussions about potential solutions that align with their personal interests. (Okada, 2020). Formal learning plays a crucial role in helping students acquire curriculum knowledge, scientific understanding, and the skills necessary to solve issues. It is vital for students to develop a solid foundation in science based on deep understanding rather than superficial memorization. This approach empowers them to effectively build knowledge and skills and engage in discussions and recontextualization with various stakeholders, including scientists, family members, and community members, fostering authentic learning within relevant contexts. By immersing themselves in real-life contexts, students expand their knowledge, develop essential skills, cultivate attitudes, and embrace values through collaborative efforts with others.

The ultimate goal is to drive change by making informed decisions, proposing solutions, or creating innovative outcomes. This nurtures students’ growth, enabling them to contribute meaningfully to their communities and make a positive impact on the world.



We want to share knowledge with others

We want to understand why knowledge is powerful

We need knowledge that will help to make changes

I am in education because society wants me to know things

I want to know what knowledge can help me in the future

Figure 6: KNOW values for sustainability; Source: Okada & Gray, 2023.

prepare action
at home with the family
WE
do
delivery action
in school with professional

In the "DO" component of Open Schooling, students are actively involved in both delivering and performing actions. They not only take actions but also carry out or perform those actions in a real-life context. This means that students acquire or build knowledge actively and also apply them with skills to solve real-world problems. By engaging in hands-on activities and practical experiences, students become active participants in the learning process and have the opportunity to make a tangible impact in their surroundings (Okada, 2020).

In the context of Open Schooling, students are encouraged to take action and apply their knowledge, skills, attitude, and values to solve real-life problems. These actions are crucial for society and contribute significantly to sustainability.

In evaluating educational outcomes, it is more meaningful to consider the actions taken or the activities resulting from learning in a specific context. For instance, assessing students' knowledge-in-action or knowledge-through-action (as depicted in Figure 7) provides a better understanding of their practical application of knowledge and skills.

We reflect and take action with others so we can collectively improve our futures

We take knowledgeable action to change the system

We achieve planetary survival with wisdom in action

Education involves doing things informed with knowledge

I think and do things because I want to improve my future

Figure 7: DO values for sustainability; Source: Okada & Gray, 2023.

CARE-KNOW-DO Learning Ecologies 2030

Ecological theories of learning highlight the importance of learning in diverse environments over time. These “learning ecologies” represent the ecological perspective on human development, where learning processes and outcomes occur within enriching habitats. The more access to learning ecologies for students to learn with open schooling richer experience they will have in authentic scenarios for personal and professional development. Learning ecologies through open schooling networks provide students with a wide range of habitats and interactions with various societal actors, including schools, outdoor spaces, living knowledge labs, universities, families, local communities, educators, and policymakers at different levels. By fostering these interactions and promoting real-life problem-solving, students’ learning experiences become more diverse, interactive, challenging, and engaging. Consequently, their learning becomes more meaningful and transformative. This approach, combined with the CARE-KNOW-DO framework, enhances students’ abilities to care about, acquire knowledge about, and take action towards sustainability. Open schooling, alongside the CARE-KNOW-DO framework, offers an ideal platform for nurturing students’ affective, mental, and physical development supported by structured materials and open scenarios. In order to support the open schooling movement and AGENDA2030, the consortium has devised a sustainable model designed to have a long-term impact over the next decade.

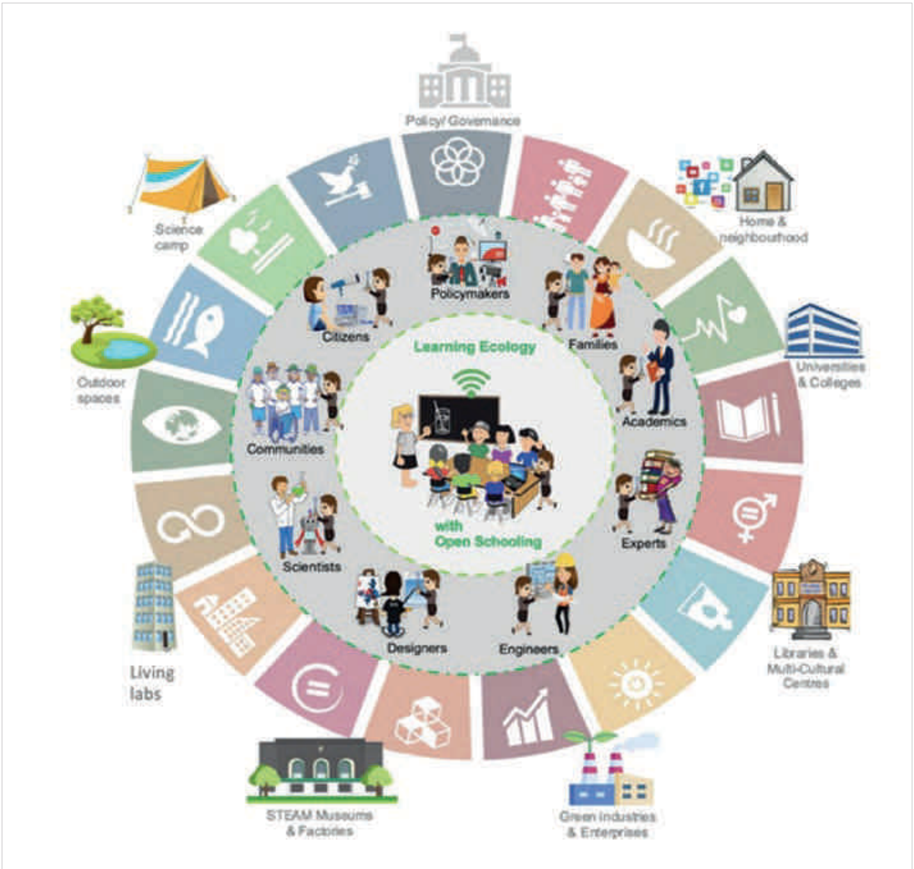

Policy/ Governance
Home & neighbourhood
Universities & Colleges
Libraries & Multi-Cultural Centres
Green Industries & Enterprises
STEAM Museums & Factories
Living labs
Outdoor spaces
Science camp
Policymakers
Families
Academics
Experts
Engineers
Designers
Scientists
Communities
Citizens
Learning Ecology
with Open Schooling

Figure 8: learning ecologies for sustainability; Source: Okada & Gray, 2023.

Science Actions

CONNECT is an inclusive, sustainable model to help more schools adopt open schooling and increase students' science capital and their aspirations to pursue science. It will embed science-action in enterprises. It aims to increase learners' interest and foster an attitude of "Science is for me" in life, now and in the future.

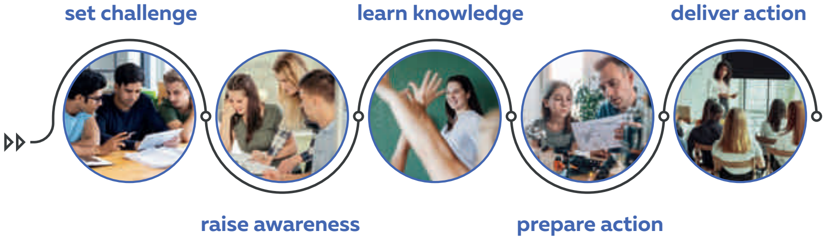


Figure 9: Open Schooling Science Actions, (Okada & Sherborne, 2018; Okada, 2020).

A science-action is a problem-solving response by students using science knowledge, skills and attitude to tackle a future-oriented socio-scientific issue. Students learn knowledge and skills and then apply it by taking actions to benefit their lives, their community and society. Figure 9 suggests a pathway for this journey. Educators and Students can adapt the journey based on their goals.

Design

The design of curriculum materials following the CARE-KNOW-DO stages are underpinned by a 'backwards design' approach. We start with the objectives for each stage, and using research-based and participatory design pedagogies, we create high quality, easy to use and inclusive materials that work well in a wide variety of classrooms.

The materials include stimulus activities for STEM professionals to engage students, awareness-raising activities for families (CARE), teacher guidelines on how to integrate the teaching of a science concept with the socio-scientific issues and problem-solving of real-life questions that matters for students (KNOW), plus activities and student sheets for students to produce the output, and guidance for STEM professional to evaluate the students' work (DO). The materials also give special attention to the RRI dimensions: gender, ethics, public engagement, and governance.

Open Schooling curriculum

Mastery Science specified criteria for partners to develop their own scenarios. Each scenario should fulfil the following CARE-KNOW-DO Framework criteria.

CARE Criteria:

Be based on a real contemporary issue: This means that the educational project should be rooted in a current and topical issue, ideally something that is being discussed in the media or is of concern to society at large.

The issue is relevant to students' concerns and interests: This suggests that the chosen issue should connect with the interests of the students involved. This relevance will help students relate the topic to their own lives and increase their motivation and engagement in the project.

The issue will be engaging to a wide variety of boys and girls: This requirement emphasizes the importance of the issue being inclusive and appealing to all students, irrespective of their gender. This could also imply that the issue should avoid reinforcing gender stereotypes.

KNOW Criteria:

The issue involves science in the country's curriculum: This means that the topic of the project should be related to the science subjects that are part of the national curriculum. This ensures that the project supports the students' formal education.

Support teaching of an important science idea: The project should help students learn and understand key scientific principles or concepts. This could mean explaining a fundamental scientific idea or showcasing how scientific knowledge is applied in real-world situations.

Result in a real-world action or student recommendations: The project should not only involve learning about science but should also allow students to apply what they've learned. This could mean coming up with suggestions for dealing with the issue being studied or carrying out a real-world action as part of the project.

DO Criteria:
Include opportunities to involve the family in discussion: The project should promote discussion outside of the classroom, such as at home with family members. This could involve students discussing what they've learned, or even getting their family members involved in project activities. Include opportunities to involve a scientist: The project should offer chances for students to interact with a professional scientist. This can offer them insights into scientific careers and the applications of science in the real world.

Develop an inquiry skill for evidence-based decision-making: The project should help students develop their abilities to conduct inquiries, interpret scientific evidence, and make decisions based on this evidence. This supports the development of critical thinking skills, which are essential in science education.

Curriculum materials examples

To help new teachers implement the curriculum materials, we have produced a set of videoclips to introduce each material. These can also be used by our coaches who prepare teachers for running projects. Table 3 presents the videos of resources in English disseminated in the UK.

Rewilding	Poo Transplant	Microplastic	Energy Savers	Carbon Neutral

Table 3: Videos produced for each structured curriculum material.

This template was designed to guide all open schooling curriculum developers from and outside the CONNECT consortium to structure the description of their learning resources in a practical way for the open schooling community to access and download them. Examples of 40 resources can be found all at the CONNECT platform https://connect-eu.exus.co.uk/category/english/

Title: is concise for recalling and disseminating

Real-problem is a brief description about a future-oriented science action related to the SDG - sustainable development goals.

Curriculum: includes content knowledge, skills, attitude, and values.

CARE-KNOW-DO activities: encourage students to identify issues that matter for them, inspire them to build and use knowledge for doing science actions and practising skills towards solutions. An important feature is fun participatory science to engage students with enjoyable approaches to interact with scientists and families. The activities are designed or adapted based on the national competency-based assessment model adapted to different countries.

References from scientists: to support schools who might find difficult to find or establish contact with scientists, the resources provide online references, which can be papers, blog articles, science-in-the-news, video clips and interviews by scientists whose work are related to the resources.

Open Educational Resources (under creative commons licence) and free download are provided for teachers, students, scientists, families and/or community members.

Figure 9: template to describe open schooling resources.

Principles used for developing structured learning materials

Many schools are not yet interested in open schooling because their focus is on easily memorisable knowledge for exams, or surface learning. You can imagine this as the visible part of an iceberg. Whereas open schooling aims more at what is beneath the surface of the iceberg: deep understanding which students can apply beyond the classroom, known as transfer. This is what students need to be prepared for further studies and interested in STEM careers. Even for non-STEM students, scientific literacy is important to engage with societal issues and think scientifically. In a world with advanced AI, we need individuals who can do more than just surface learning. In CONNECT, science education has bigger goals.

We can bring together the different perspectives by viewing learning as a journey from surface learning to deep learning to transfer knowledge (Hattie, 2016). In our model in "KNOW" phase corresponds to the surface learning but some CONNECT Science actions add activities to deepen learning (Frey et. al, 2017). Whereas the DO phase is about transfer of knowledge and skills to new contexts. The social context initiated in CARE is also an important factor in helping students transfer knowledge from classroom to real world. Hence, CONNECT encourages the interact with families to relate the science to real-life concerns and with scientists to model authentic ways of thinking scientifically confidence with using science in their lives. The three components of the framework CARE-KNOW-DO are thus mutually supportive to enhance students' connections with science and equally essential for sustainability.

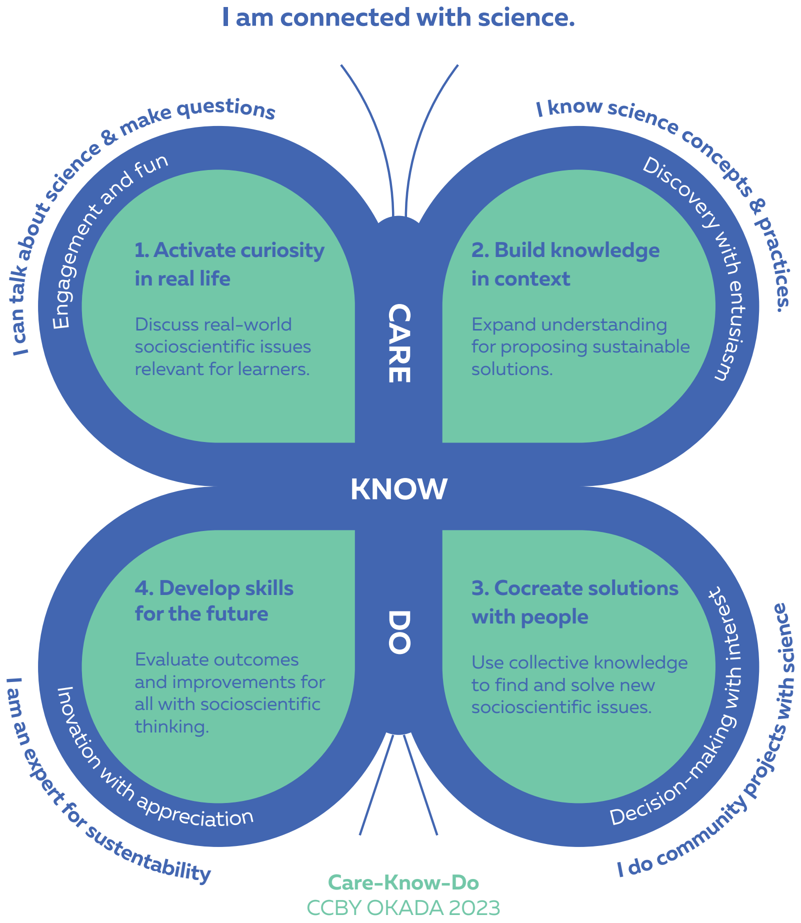

I am connected with science.
I can talk about science & make questions
Engagement and fun
1. Activate curiosity in real life
Discuss real-world socioscientific issues relevant for learners.
I know science concepts & practices.
Discovery with entusiasm
2. Build knowledge in context
Expand understanding for proposing sustainable solutions.
CARE
KNOW
DO
4. Develop skills for the future
Evaluate outcomes and improvements for all with socioscientific thinking.
I am an expert for sustentability
Inovation with appreciation
3. Cocreate solutions with people
Use collective knowledge to find and solve new socioscientific issues.
Decision-making with interest
I do community projects with science
Care-Know-Do
CCBY OKADA 2023

Figure 10: CARE-KNOW-DO principles for supporting curriculum designers Source Okada, 2023.

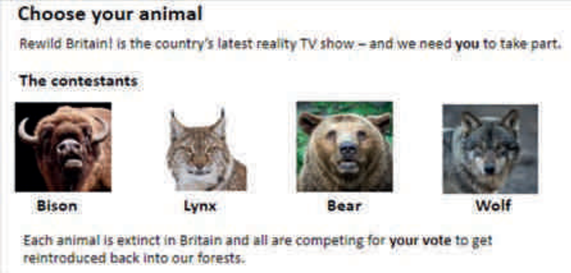
Rewilding

The issue: Human activity has led to an alarming rate of biodiversity loss over the past 50 years, impacting our well-being and causing the disappearance of 68% of animal species. In response, rewilding initiatives seek to restore nature's biodiversity and natural processes. Rewilding is about reintroducing lost animal species to ecosystems for the benefit of wildlife, people, and climate. These initiatives create opportunities for ecological restoration, wildlife observation, and sustainable use of natural resources. The Rewilding science-action encourages students to use their understanding of interdependence and evidence analysis skills to plan a campaign promoting animal rewilding.

CARE: Students are presented with the real-life challenge of exploring their region, selecting a rewilding candidate, and persuading the public of its benefits. With rewilding projects underway in various countries, this exercise provides students with an active role in contemporary environmental action.

The educational journey begins by sparking student interest in the topic. The first stage introduces rewilding through a classroom discussion, potentially with a scientist's input, either in-person or virtually. If a scientist isn't available, educational videos are provided in our guides.

Subsequently, families explore this topic at home with resources available on the CONNECT platform or their school's Virtual Learning Environment (VLE). The materials, designed for mobile or printed formats, feature animals advocating for their rewilding. Families discuss the pros and cons of each option, ultimately voting for their preferred candidate.

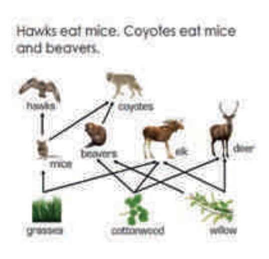


Choose your animal

Rewild Britain! is the country's latest reality TV show – and we need **you** to take part.

The contestants

Each animal is extinct in Britain and all are competing for **your vote** to get reintroduced back into our forests.



Hawks eat mice. Coyotes eat mice and beavers.

KNOW: Upon returning to school, students discuss voting results and learn about feeding relationships, applying these to real-life scenarios. For example, they examine how the reintroduction of wolves into an elk-populated national park restored the biodiversity balance.

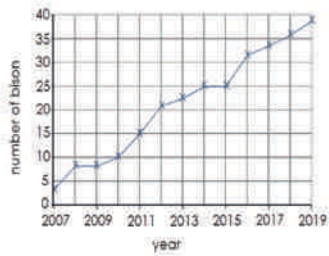
An independent study phase allows students to apply these concepts at home. Given a woodland food web, they analyse the effects of rewilding on the ecosystem's organisms. This task provides an opportunity for peer assessment and reinforces the use of evidence and data analysis skills.

If possible, a scientist can assist in data analysis, illustrating how these skills are utilised in their professional lives.

DO: The final stage involves students planning their rewilding campaigns. They analyse data taken from other rewilding projects, scientist's models and public surveys to write a persuasive argument. They then present their presentations to the class with potential scientist feedback, allowing students to practise their communication skills. In essence, this approach provides a hands-on understanding of the significance and impact of rewilding.

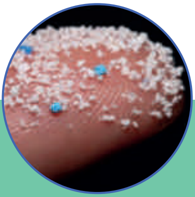
LEARNING WITH SCIENTISTS ABOUT REWILDING

CONNECT included two opportunities for students to learn from a scientist. The first video discusses a pioneering project where European bison have been introduced into ancient woodland for conservation purposes to explore the benefits that bison can bring to woodland habitats, including increased biodiversity, the creation of open spaces, and rejuvenation of the woods.



The video features an interview with Dr Lawrence Ball, Conservation GIS and data officer, Kent Wildlife Trust. The researchers hope the project will increase structural diversity in the woodland, create more habitats, provide more food for other species, and ultimately enhance biodiversity. Students will learn with scientists the potential nature-based solution for woodland restoration and is hoped to inspire similar projects across the UK.

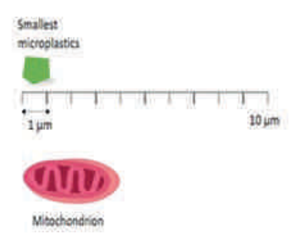
Microplastic



The issue: Microplastics, minuscule plastic fragments contaminating our environment, present one of the most urgent environmental issues. They are created when plastic waste breaks down into smaller particles and contaminate the water, soil, and air, posing threats to both human health and marine ecosystems. Without timely action, the volume of ocean microplastics may soon surpass that of fish. In the Microplastics science-action program, students are empowered to become activists to mitigate this pressing issue. The Microplastics science-action is a short activity, taking 1.5 lessons and homework assignments. These open schooling activities give students opportunities to apply their knowledge of particle model and separating mixtures and practise their design and communication skills.

CARE: Students begin by studying the microplastic issue and learning about its causes and problems.Families are engaged by examining their daily plastic use and disposal habits, prompting reflection on the lifecycle and ultimate fate of plastic waste.

KNOW: After learning about particle model and separating mixtures, students learn about the scale of microplastics. Understanding the scale of very small objects is one area we have identified that many students struggle with, but it is not often taught in schools.



DO: They are asked to help design a filter that can be used as part of a washing machine to stop microplastics shed from clothes entering the water supply. They present their designs to the class, describing how it works and how it can help with the microplastics problem.

LEARNING WITH SCIENTISTS ABOUT MICROPLASTICS

Professor Richard Thompson provided an interview for the CONNECT network of schools. He is a marine biologist at the University of Plymouth, who discovered the pervasive issue of microplastics during his PhD training. Originally studying larger marine life, he found his experiments on shores constantly disrupted by litter, inciting his curiosity about its origins.

MICROPLASTICS: DISCOVERIES, SOLUTIONS, AND THE NEED FOR CHANGE

In our CONNECT video series, students explore the world of microplastics and the work of dedicated scientists in understanding and addressing this environmental concern. Prof. Richard Thompson discusses his unforeseen discovery of microplastics and the importance of curiosity in scientific breakthroughs. Collaborating with volunteer groups and the Marine Conservation Society, he documents beach litter in Excel and investigates microplastics through microscopic analysis. His research reveals their prevalence in ocean waters and their impact on marine life.

In a follow-up video, Prof. Thompson addresses potential solutions for the microplastic problem based on student questions. He emphasizes the need for tailored approaches as different countries face unique challenges. In regions lacking waste management infrastructure, establishing such systems is crucial, while areas with advanced waste management focus on sustainable product design and considering end-of-life implications. The rise of single-use plastics necessitates a shift in design philosophy. Another video highlights the role of product designers in tackling microplastics. Many non-recyclable and non-reusable plastic products contribute to significant waste accumulation. To address this, a change in design philosophy is necessary, moving away from disposable plastics and considering sustainable alternatives.

Additionally, Dr. Fay Couceiro, a pollution expert, explains microplastics and their sources in simple terms. She emphasizes the difficulty of removing microplastics due to their small size and advocates for preventing their entry into the environment by addressing larger plastic waste.

Overall, the journey through the world of microplastics showcases the importance of scientific curiosity, collaboration, responsible product design, waste management, and preventing plastic pollution. These efforts pave the way for a cleaner, more sustainable future.

Carbon Neutral

The problem: Despite our advancements, we're overwhelmed by rapid climate change due to greenhouse gases. It's not as simple as changing our lifestyle or investing in renewable energy. Our industrialised society, by nature, damages the biosphere, contributing to climate change through various sectors, even those not typically associated with high emissions. Technologies could potentially capture and store carbon dioxide, but the current cost is prohibitively high. Governments, despite being logical funding sources, often support fossil fuels, which keeps goods cheap and politically popular, perpetuating the cycle. Solutions range from moving away from capitalism to reducing growth as a species, but no political system has yet successfully achieved sustainability. We lack the time for extensive experiments and urgently need to implement solutions to reduce greenhouse gases and lower CO2 levels. It's not enough to mend our ways; we must actively rectify our past mistakes, as each wasted year leads to inevitable extreme changes."Connect Science Action: Carbon Neutral," is an open schooling resource integrated to the curriculum (10-14-year-olds) that addresses carbon emissions, climate change, and global warming.

CARE: Students first consider perspectives on promises made by governments to reduce carbon emissions. To aid their understanding, students view a video featuring Greta Thunberg, who questions the efficacy of these promises. Students learn how we need to influence decision-makers to act on climate change. The problem-solving aspect is introduced, which involves aiding a company to reduce its carbon footprint and attain carbon neutrality. In this scenario, students act as climate consultants for a café owner. For the home task under the 'Care' stage, families discuss carbon footprints and calculate theirs using an online tool. They learn how we can make personal changes like eating less meat, flying less, or getting an electric car. Not out of guilt or the belief that one person can stop climate change, but to contribute a tiny part to the systemic change we need. They then make pledges to reduce their carbon footprint, getting closer to carbon neutrality.

Are real changes going to be made?
Click for video
Or will it all be
BLAH
BLAH
BLAH ?

KNOW: In the first activity the teacher demonstrates how to identify sources of carbon emissions within an industry, using fast fashion as an example. Following this, students apply what they've learned to determine how the café emits carbon. They examine aspects like transport of goods and waste disposal.

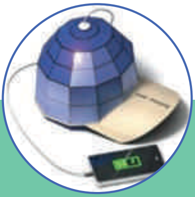
In the second 'Know' activity, students first learn a skill by playing a game. They then apply this skill to identify what changes the café needs to make to become carbon neutral. They consider potential changes from the first 'Know' activity, assessing the cost and effectiveness of each in terms of reducing CO2 emissions.

DO: At home, students and their families explore carbon offsetting. Affluent individuals can support low carbon technologies by investing in them while they're still expensive, driving prices down for the future. They examine different options for investing in companies that could offset their carbon footprint and discuss which option they would choose and why. Back at school, students work in groups to plan their recommendations for the café, drawing on everything they've learned. They then present these recommendations. This comprehensive Science Action connects scientific knowledge, practical application, and real-world problem-solving, fostering a deeper understanding of carbon neutrality.

LEARNING WITH SCIENTISTS ABOUT CARBON NEUTRAL

Students can learn with Professor Nilay Shah's view interview, about low carbon technologies. He emphasized the need to reach net zero emissions by 2050, which is a significant challenge requiring contributions from everyone. He shows the steps companies can take to achieve carbon neutrality. They should start by assessing their carbon footprint, considering factors like heating methods, electricity sources, and supplies. Companies can then transition to low carbon heating and seek out suppliers offering lower carbon electricity. He also highlighted the hidden carbon emissions associated with digital activities, particularly server data storage in the cloud. Major transformations in energy, industry, and transport systems are necessary to achieve zero emissions. He emphasized the role of governments and large corporations in driving these transformations and being held accountable. He also expressed optimism due to widespread support from individuals, governments, and local authorities.

Energy Savers

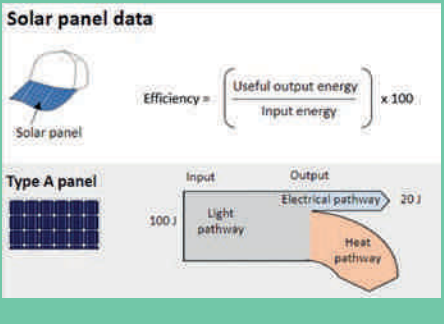


The problem: A pressing issue prevalent in news across Europe is rising energy costs. Additionally, the curriculum highlights the environmental implications of electricity generation through burning fossil fuels, an activity that contributes to pollution and high carbon levels. Individuals can make choices such as using energy efficient devices, switching to electric heat pumps and cars and installing solar panels at home in order to help with the ongoing energy crisis.

Energy Savers is a physics-based Science Action, focusing on energy transfers and energy efficiency. The primary skill emphasised is the application of percentages, a mathematical concept.

CARE: In the 'Care' activity at school, students are challenged to help an entrepreneur invent an energy-saving device for use in domestic environments.

In the at-home task, families assess ten potential energy-saving devices proposed by the entrepreneur. They critically examine each device based on its utility and energy-saving capability compared to traditional appliances.



Solar panel data

$$\text{Efficiency} = \left(\frac{\text{Useful output energy}}{\text{Input energy}}\right) \times 100$$

Type A panel

Coffee Chum

Plug in this reusable coffee cup and charge it up.

One example given is a reusable coffee cup, "Coffee Chum," which can be charged to keep coffee warm. The families then rank these devices based on their evaluations and select their favourite ones, which students then present at school.

KNOW: Although this Science Action does not contain a 'Know' activity; teachers should interact with students for them recall concepts and revise their understanding on energy transfers and energy efficiency.

DO: Here, students discover that the entrepreneur has chosen to develop a solar hat - a cap equipped with a solar panel for charging a phone. Students are tasked with designing a funding page, akin to a Kickstarter campaign, to raise money to produce and sell this hat. In this activity, students apply their scientific knowledge about energy transfers and efficiency. They are expected to incorporate an energy transfer diagram in their funding page and help decide which type of solar panel to use on the hat. Considerations for this decision include the efficiency and cost of different solar panels. The completion of this funding page constitutes the final output of the 'Do' activity, signifying the application of theoretical knowledge and critical thinking in a practical, real-world context. This creative exercise not only reinforces the concepts learned but also demonstrates the potential of scientific knowledge in addressing contemporary issues.

LEARNING WITH SCIENTISTS ABOUT ENERGY SAVING

Students can learn with Nick Eyre, Professor of energy and climate policy at the University of Oxford. In the video he talked about how work on climate mitigation and energy use can help the environment. He mentioned some ways of saving energy in the home like switching lights off when you leave a room. He acknowledged that these things make a very small difference but will have more effect if everybody does them. The bigger things are making changes such as using an electric car, insulating houses and switching away from using gas to electric heat pumps to heat the home. Also, we can all think about how we get around, and walk, cycle and use public transport more.

He talked about how the UK is doing in switching to renewables and how other scientists at the University of Oxford are working on more efficient solar panels, and why this is important, providing a link to the DO task in the Energy Savers Science Action. He highlights that the main cause of carbon dioxide emissions is energy consumption. Efforts are being made to transition from fossil fuels to renewable energy sources such as solar power, wind, and hydropower. It is crucial to increase the utilization of renewable energy, but we must also consider three key aspects: reducing energy usage, shifting away from direct fossil fuel use (e.g., petrol in cars and gas in boilers), and adopting flexible energy usage over time.

Handwashing

The problem: Microorganisms cause roughly 200 types of infections which are transmitted when we come into contact with contaminated individuals or surfaces, and subsequently touch our eyes, nose, or mouth. Hand hygiene, a simple and effective practice, significantly mitigates the spread of infectious diseases like conjunctivitis, flu, gastroenteritis, etc., which are common within schools. During the COVID-19 pandemic, regular handwashing with soap and water, or sanitising with hydro alcohol-based solutions, emerged as a vital precautionary measure. Infectious agents can be transferred via primary contact (physical contact with an infected person) and indirect or fomite contact (with objects or substances harbouring infectious agents).

In this Science Action, students take part in a school-wide competition to design a poster for World Hand Hygiene Day, observed annually on May 5th under WHO's initiative. The aim is to reach a consensus on proposals for improving strategies for the prevention and control of infectious diseases such as those caused by SARS-CoV-2, influenza, and other viruses in schools, through a participatory research process that involves teachers, students, and their families. The aim is to explore how the implementation of disease prevention and control measures can be improved by incorporating the perspectives of members of the educational community. It also offers the possibility for teachers and families to work together on a project that will develop students' skills and aptitudes, foster an interest in science, enhance perceptions of science careers, and develop students' ability to use the scientific method to resolve real problems in their community.

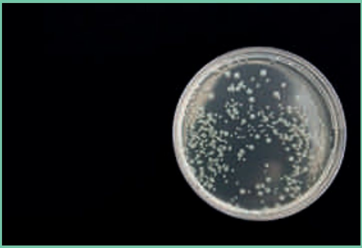
CARE: Students participate in an interactive handwashing competition and brainstorm together on the importance of handwashing in preventing the spread of infectious diseases.

At home students experiment to test if their hand washing is effective and symbolically demonstrate the effect of soap on hand germs.

KNOW: Students learn how to wash their hands properly and then do experiments to show the presence of germs on their hands and explore the relationship between hand washing and germ removal.

Two experiments involving inoculation are suggested: option A (described in Student Guide A) with culture plates in the laboratory, and option B (described in Student Guide B), with pre-sliced bread in the classroom. Teachers can choose the most appropriate option, depending on the characteristics of their students and/or available resources.

Both experiments compare the growth of microorganisms when agar (in the laboratory) or bread (in the classroom) is exposed to clean and unwashed hands. Students then interpret the results, differentiating between bacterial and fungal colonies, and correlate the findings with healthy habits.



DO: Students answer questions related to the experiments and think about how hand washing relates to the germs on their hands. Students participate in a poster contest to help promote hand washing to prevent the spread of infections. The school uploads the winning poster to its usual communication channels (website, social media, etc.)

LEARNING WITH SCIENTISTS ABOUT HAND WASHING

In this video, Dr John Williams, chief of the Division of Pediatric Infectious Diseases at UPMC Children's Hospital of Pittsburgh, explains why hand hygiene is critical to illness prevention. He explains:

> *"The importance of handwashing is that hands are the primary mode of transmission of almost every germ we know. All of us touch or hands and face hundreds or even thousands of times a day without being aware of it and then we're touching things in our environment...So keeping our hands clean reduces the chance that we will contaminate one of these surfaces around us or transmit the germ to another person around us."*

Competence-based assessment

In the CONNECT open schooling model, competency-based assessment was localised to fit to the national curriculum in 5 countries considering the content, pedagogy and assessment. In the UK, to fit in the curriculum the models linked to the UK curriculum to support competence-based assessment: inquiry skills, communication skills and green skills. Although the term competence is used more frequently in Higher Education in some countries, for example, in the United Kingdom (https://www.advance-he.ac.uk/guidance/equality-diversity-and-inclusion/student-recruitment-retention-and-attainment/inclusive-learning-and-teaching/competence-standards-and-reasonable-adjustments), the CONNECT team designed the open schooling resources considering the term "competence" as the set of knowledge, skills, attitude and values to help students to succeed in their personal, professional and societal life.

Inquiry skills

The model for the inquiry skills is based on the 'working scientifically' statements from the English National Curriculum for KS3 science and the UK Blueprint curriculum. They were developed during previous EU-funded projects: ENGAGE and TEMI, where additional skills were added to statements from the National curriculum to cover skills important for RRI (responsible research and innovation).

This new set of skills were embedded into a KS3 curriculum (ages 11 – 14) co-created with the exam board, AQA, which was published in 2016 (https://www.aqa.org.uk/subjects/science/ks3/ks3-science-syllabus/specification-at-a-glance). These skills are embedded into CONNECT's science actions, and the model has been further refined and adapted to other countries.
The following list shows a set of specific inquiry skills embedded in the resources or used to produce them.

Exploration

In the exploration stage, students are introduced to a topic or a question that sparks their curiosity. They engage in activities that encourage them to explore and gather information, often through hands-on experiences, research, and discussions. This stage is focused on generating questions, making observations, and developing a foundational understanding of the topic.

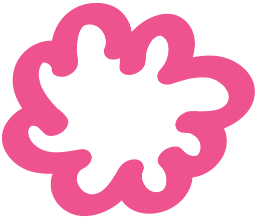
- **Find relevant information:** Find relevant information from texts, websites, or diagrams.
- **Judge quality of sources:** Judge whether a source is unbiased, or its claims are backed up by evidence.
- **Devise a test:** Think up an experiment, or situation to test whether a claim, hypothesis or model is correct.
- **Choose an appropriate method:** Choose a method and apparatus that can collect precise and accurate data.
- **Determine variables:** Determine independent, dependent and control variables to answer a scientific question.
- **Make a hypotheses or claim:** Invent a testable explanation for an observation based on a scientific idea or turn a scientific question into a claim.
- **Consider different perspectives:** Consider social, environment, economic or ethical factors in a science or technology decision.

Investigation

Once students have a basic understanding of the topic, they move on to the investigation stage. Here, they delve deeper into their inquiries by conducting experiments, analysing data, and seeking additional information. They formulate hypotheses, design experiments, and test their ideas to gather evidence and make connections between concepts. This stage encourages critical thinking, problem-solving skills, and the application of knowledge to real-world situations.

- **Determine suitable values:** Determine what values and range of data are sufficient to test the hypothesis.
- **Identify hazards:** Identify the hazards of an experiment or technology or their seriousness.
- **Identify experimental limitations:** Identify sources of uncertainty or the limitations of collected data as evidence.
- **Predict results:** Predict the outcome of an experiment, or an observation, based on a hypothesis, model or claim.
- **Reason from models:** Reason about a phenomenon in terms of relevant features or behaviour of a model

- **Identify relationships & patterns:** Read graphs, identify direct or inverse relationships, and recognise correlations.
- **Construct charts & graphs:** Construct line graphs, bar or pie charts, or histograms, from data
- **Support claims with evidence:** Argue for a claim by explaining how each piece of evidence supports it or not.
- **Review hypotheses against evidence:** Review a hypothesis against the evidence collected to test it.



Conclusion

In the conclusion stage, students reflect on their findings, draw conclusions, and communicate their understanding. They analyze the data they have collected, evaluate their hypotheses, and draw connections between their findings and existing knowledge. Students are encouraged to articulate their thoughts, present their findings, and engage in discussions to deepen their understanding. This stage emphasizes reflection, critical analysis, and the ability to communicate findings effectively.

- **Weigh evidence for conclusions:** Determine how well the evidence supports a claim.
- **Represent with models:** Represent a phenomenon, process or system with a diagram or symbols, based on a model.
- **Compare models against data:** Evaluate how well a model fits a set of data or observations of a phenomenon.
- **Present information clearly:** Communicate for purpose & audience.
- **Make sense of text:** Interpret a text by drawing inferences, expressing its main idea or giving an accurate summary.
- **Explain ideas orally or in writing:** Explain and justify points to a group.
- **Write coherently:** Write an answer with sentences in a logical structure and accurate terminology.

Green skills and CARE-KNOW-DO

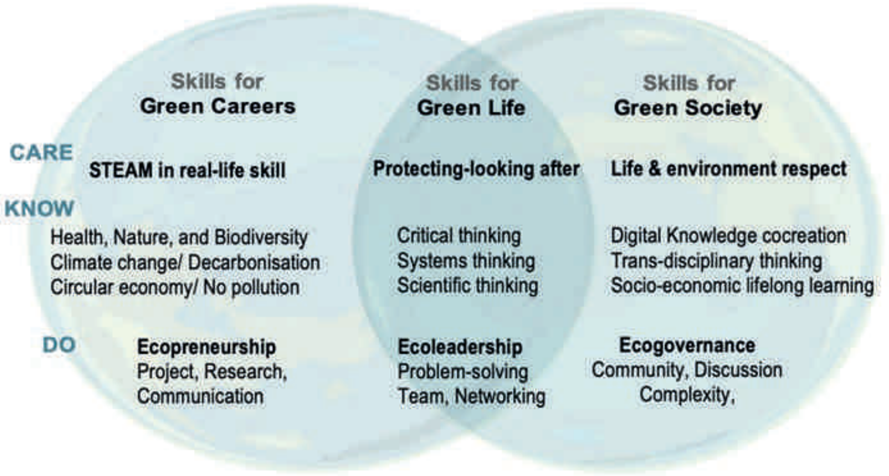

Skills for Green Careers
Skills for Green Life
Skills for Green Society
CARE
STEAM in real-life skill
Protecting-looking after
Life & environment respect
KNOW
Health, Nature, and Biodiversity
Climate change/ Decarbonisation
Circular economy/ No pollution
Critical thinking
Systems thinking
Scientific thinking
Digital Knowledge cocreation
Trans-disciplinary thinking
Socio-economic lifelong learning
DO
Ecopreneurship
Project, Research,
Communication
Ecoleadership
Problem-solving
Team, Networking
Ecogovernance
Community, Discussion
Complexity,

Figure 11: CARE-KNOW-DO principles for supporting curriculum designers Source Okada 2023.

Green skills encompass learners' abilities for green careers, green life, and green society. A recent literature analysis explored the interrelationships between green skills components, values, knowledge, and actions.
The CARE-KNOW-DO principles were used to identify skills for engagement, knowledge, and action (Okada, Gray, 2023). Figure 11 illustrates the sets of skills for green careers, green life, and green society, emphasizing the connection between formal, informal, and non-formal learning. This model supports stakeholders and organizations, enhancing students' understanding and appreciation of science's role in shaping the future.

'CARE' refers to the type of skills learners need to develop to ensure that values and local needs are taken into account from the perspective of enterprises (green careers), individuals (green life), and communities (green society). Three green skills were selected to be embedded in the resources.

- **STEAM in real-life** means the ability to identify real-life issues using Science, Technology, Engineering, Arts, and Maths, relevant for green careers.

- **Protecting-looking after** refers to the ability to take care of oneself and others, relevant for green life.

- **Respect for life and environment** focuses on the ability to value health and wellbeing and reflect on socio-scientific issues that may affect living organisms and the environment, relevant for green society.

'KNOW' refers to transferable and subject matter knowledge skills to solve problems, develop new products or processes, or train others, which are clustered into three domains. In terms of Green Careers, three skills were selected to be embedded in the materials.

- **Health, nature, and biodiversity:** ability to understand about good health and life on Earth, freshwater, renewable energy, nutrition and food security, medicines, and protection of living beings.

- **Climate change decarbonisation:** ability to understand about global warming and greenhouse gas emission, mitigation actions to reduce emissions and adaptation action to manage the risks.

- **Circular economy with no pollution:** ability to understand about regenerating nature and keeping waste out of the environment by sharing, reusing, repairing, and recycling existing materials and products as long as possible.

Regarding Green Life, three skills were integrated in the activities.

- **Critical thinking:** ability to analyse, evaluate and develop an argument, along with the evaluation of evidence, including concepts, principles, and assumptions.

- **Systems thinking:** ability to explore and develop effective strategies in complex contexts considering the whole and the relationships of interconnected components instead of splitting it down into its parts.

- **Scientific thinking:** ability to solve problems supported by scientific sources, scientific methods, and scientific experts.

To support green society, three skills were selected for teaching guidelines.

- **Knowledge co-creation with digital access:** ability to communicate one's own understanding and evaluate others' views to build knowledge collaboratively on the internet.

- **'Multi/inter/trans' disciplinary thinking:** ability to participate in multi-, inter-, or transdisciplinary learning incorporating integrated thinking, supported by all branches of sciences (natural, mathematics, human and social sciences).

- **Socio-economic lifelong learning:** ability to benefit from lifelong learning for future well-being, supporting green socio-economy.

'DO' brings together three groups of skills embedded in guidelines for teachers and activities. The first group is towards green careers:

Ecopreneurship: ability to situate nature, climate, and health at the core of a business model with income for local livelihoods supported by more resilient, inclusive, and sustainable approaches. This is relevant for green careers and is embedded in coaching resources too. It includes three sets of skills:

- Project management for RRI: ability to create and develop projects with the team members considering scientific and technological advances aligned with societal needs.

- Digital research and data science: ability to answer to question or solve problems with methods and data analysis.

- Communication: ability to communicate clearly and scientifically considering diversity, inclusion, and equity.

Eco Leadership: ability to lead collective actions supported by other individuals and communities to ensure a healthy life, environment, and economy with sustainable development. This is relevant for green lives and includes three sets of skills as follows.

- Problem-solving/Decision-making: ability to identify and use, reliable sources of information to respond to problems and make decision

- Teamwork Negotiation: ability to support group negotiation that can lead to improved outcomes, resolution of conflicts and increased team cooperation.

- Social Networking: ability to build and nurture interactions, connections, and relationships with others.

Eco governance: ability to design, implement and evaluate policies and manage change in order to support positive impact by facing barriers, maximising benefits, and reducing risks for society. This is relevant for green societies and includes three sets of skills as follows.

- Socio-scientific argumentative discussion: ability to discuss the social consequences with arguments and evidence from multiple, reliable sources.
- Working together within Complexity: ability to investigate complex questions, scenarios, weigh the evidence, identify, and interpret uncertainty.
- Sustaining strong communities: ability to develop and sustain strong communities by engaging all members and external public.

RRI skills from the Comprehensive Competence Framework

In Spain, the resources, coaching, and teaching guidelines considered the national curriculum specification and also the Comprehensive Framework of RRI Competences with 8 sets of skills (Malagrida et. al. 2022). The framework is underpinned by RRI process requirements to prepare young people to contribute to the alignment of scientific research and innovation with societal needs. This is an important framework authored by IRSICAIXA who has participating in various European funded projects in Responsible Research and Innovation (RRI) and in CONNECT was responsible in developing the health structured and open scenario tools such as system-oriented dialogue model (Malagrida et' al. 2023).

The framework (Malagrida et. al. 2022, p.8) presents 8 sets of abilities to guide educators and learners to develop key competences which are vital for shaping a desirable and sustainable future, which we summarise as follows.

'Recognising scientifically investigable questions'. This refers to the abilities to identify and understand problems and societal issues using an interdisciplinary scientific approach and considering societal perspectives and interests. This also involves crafting or choosing research questions for scientific investigation that can generate novel and valuable ideas, transformative concepts, or innovations.

'Identifying evidence needed in a scientific investigation'. This refers to the abilities to find and generate necessary information to validate predictions, such as deciding comparison aspects, variables to be adjusted or controlled, and requiring additional contextual information. They also involve evaluating the validity, recency, and credibility of various sources, checking for biases, and assessing the supporting evidence. Moreover, these abilities include distinguishing among scientific, social, and ethical propositions, and recognizing that differing views may exist among experts and non-experts.

'Method definition'. This skill involves the ability to design research methods with considerations like gender equality and demographics, including race, class, gender, sexual orientation, country of origin, culture, religion, and political affiliation. It also includes considering alternative research and innovation paths, while ensuring clear and honest representation of methods and objectives.

'Drawing conclusions with scientific, ethical, legal and social reasoning'. This refers to a set of abilities that involves using various reasoning types, and assessing if conclusions are evidence-based. They include evaluating the sufficiency of information supporting claims, considering conflicting information in final results, and ensuring the quality and accuracy of evidence. These abilities also encompass understanding different viewpoints and forming opinions on real-world problems based on scientific knowledge, risk analysis, and considering broader impacts. Additionally, they involve anticipating the potential impacts of a practice and understanding how the complexities and uncertainties in scientific projects influence problem-solving in socio-scientific issues.

'Communication skills' this involves the ability to communicate information and deliver training about various project aspects including uncertainties and resources, using multiple formats, and ensuring the data is supported by evidence and comprehensible to different stakeholders. This includes the capacity to examine a research practice's open access policy, its accessibility to stakeholders, and whether its outcomes are published through open access.

'Demonstrating understanding of scientific concepts'. This refers to making inference, providing explanations and offering interpretations grounded in a comprehension of scientific, ethical, societal, legal, and environmental principles.

'Engagement skills'. These abilities involve engaging in reasoned dialogue and argumentation to articulate and persuade various viewpoints, considering multiple aspects like impacts, alternatives, and social values. They include actively involving diverse stakeholders in research based on factors such as gender, ethnicity, and interests, and supporting public contributions to research and innovation. These skills also entail understanding the roles of different actors, participating in community activities, and decision-making at various levels. Additionally, they include demonstrating solidarity by showing interest in and helping solve problems affecting communities, both local and broader.

'Evaluation with critical thinking, flexibility and adaptability'. These abilities encompass devising and executing strategies to assess research integrity, addressing uncertainties, limitations, fraud, stakeholder involvement, and openness in research and innovation processes. They also effectively incorporate feedback from diverse perspectives and in varied social and ethical contexts. They include the capacity to listen with respect, patience, care, and honesty.

Open Schooling 2023: the year of Skills

In today's society and economy, digital proficiency has become a necessity. It's pivotal to societal inclusion, personal well-being, civic engagement, career opportunities, productivity, safety, and growth. They are fundamental tools for staying informed, exercising rights, accessing online services, communicating, and for producing and sharing digital content.

The European Council has emphasised the necessity of proactive measures to enhance the skills necessary for the green and digital transition. They advocate for education, training, and both upskilling and reskilling as a response to the issues of labour shortages and job evolution, particularly in light of socio-economic and demographic challenges.

The year 2023 has been designated as the European Year of Skills by the President of the European Commission. This has inspired a political consensus among the European Parliament and Member States to collectively advance skills development initiatives.

The 2022 European Declaration on Digital Rights and Principles for the Digital Decade outlines how Europe's core values and basic rights should be upheld in the digital sphere. It asserts that human beings should be at the forefront of digital transformation, which should contribute to a just society and economy, and that acquiring digital skills is a right for everyone.

The European Pillar of Social Rights also acknowledges the significance of digital skills as its first principle. As a result, there's a call for educational and training systems to back the development of digital skills among all citizens. Additionally, non-formal education providers are contributing to this effort by offering diverse educational opportunities for individuals of all ages.

Digital Skills

The DigComp framework promoted by the European Union defines digital competence as a combination of knowledge, skills, and attitudes. It enables the "confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society. This framework identifies 5 areas grouping key skills to foster digital competences. The areas including skills are summarised below:

1. **Information and data literacy:** To articulate information needs, to locate and retrieve digital data, information and content. To judge the relevance of the source and its content. To store, manage, and organise digital data, information and content.

2. **Communication and collaboration:** To interact, communicate and collaborate through digital technologies while being aware of cultural and generational diversity. To participate in society through public and private digital services and participatory citizenship. To manage one's digital presence, identity and reputation.

3. **Digital content creation:** To create and edit digital content. To improve and integrate information and content into an existing body of knowledge while understanding how copyright and licences are to be applied. To know how to give understandable instructions for a computer system.

4. **Safety:** To protect devices, content, personal data and privacy in digital environments. To protect physical and psychological health, and to be aware of digital technologies for social well-being and social inclusion. To be aware of the environmental impact of digital technologies and their use.

Problem solving: To identify needs and problems, and to resolve conceptual problems and problem situations in digital environments. To use digital tools to innovate processes and products. To keep up-to-date with the digital evolution.

Open Schooling and Digital Education Action Plan in Europe

Though new approaches such as open schooling initiated during the COVID-19 pandemic faced numerous challenges, the necessity of school closures and social isolation measures accelerated the ongoing transition towards online and hybrid learning models. This situation sparked innovative strategies for students and teachers to manage their tasks and enabled more personal, flexible interactions online. However, the rapid move towards digital learning also exposed certain issues and inequalities. A digital divide emerged between those who could access digital technologies and those who couldn't, often leaving those from disadvantaged backgrounds behind. Similarly, concerns related to the digital readiness of educational and training institutions became prominent, as well as issues around teacher training and the overall level of digital skills and competences. These diverse challenges emphasise the need to tackle disparities and boost digital proficiency across all dimensions of the educational field.

During the launch of four EU-funded open schooling projects - CONNECT, MOST, MIO, SALL - on September 30, 2020, the Digital Education Action Plan (2021-2027) was introduced.

This comprehensive EU initiative aims to promote a unified vision of high-quality, inclusive, and accessible digital education across Europe. With the goal of responding to the challenges posed by the COVID-19 pandemic, the action plan seeks to facilitate the transition of education systems into the digital age while fostering increased cooperation at the European level.

The Digital Education Action Plan encompasses two overarching priorities and includes a set of 13 specific actions designed to achieve its objectives. These actions can be summarized as follows:

Fostering the use of digital technologies for better learning and teaching: The plan aims to encourage the widespread adoption and effective use of digital technologies in education. It emphasizes the importance of pedagogical innovation, personalized learning, and the use of open educational resources.

Additionally, it supports the implementation of advanced technologies such as artificial intelligence, virtual reality, and learning analytics to enhance learning experiences and outcomes.

Enhancing digital skills and competences: The action plan focuses on equipping learners, educators, and other stakeholders with the necessary digital skills and competences to thrive in the digital era. It promotes the development of digital literacy, critical thinking, and digital citizenship among learners, while supporting the professional development of educators to effectively integrate technology into teaching and learning.

These priorities and actions outlined in the Digital Education Action Plan serve as a roadmap for advancing digital education in Europe. By promoting collaboration among schools, academic institutions, researchers, and policymakers, the plan aims to create a supportive and enabling environment for the successful implementation of digital education initiatives. Ultimately, it seeks to ensure that all learners have equal opportunities to access high-quality education and acquire the digital skills necessary for their personal and professional development in the digital age.

Priority 1: Fostering a high-performing digital education ecosystem.

Action 1:	Digital education and skills and training.
Action 2:	Blended learning for inclusive primary and secondary education.
Action 3:	Digital Education Content Framework.
Action 4:	Connectivity and digital equipment for education and training.
Action 5:	Digital transformation plans for education and training institutions.
Action 6:	Ethical guidelines about AI and data in teaching-learning for teachers.

Priority 2: Enhancing skills and competences for the digital transformation.

Action 7:	Fostering digital literacy and tackling disinformation.
Action 8:	Including AI and data-related skills.
Action 9:	Digital Skills Certificate (e.g., DSC).
Action 10:	Education and training to foster and enhance digital skills.
Action 11:	Cross-national collection of data about student digital skills.
Action 12:	Digital Opportunity Traineeships.
Action 13:	Women's participation in STEM.

To face the shortage of skills across nations as a major challenge the current year of 2023 was proposed as the Year of Skills.

The European Commission adopted a comprehensive digital education and skills package on the 18th of April 2023. The European Commission's digital education and skills package includes two proposals. The first proposal focuses on empowering teachers by developing their digital skills through training and professional development, enabling them to effectively use digital technology in teaching and learning. The second proposal emphasises improving the provision of digital skills for students, with an emphasis on early skill development and high-quality informatics in schools. Both proposals aim to support the overall goal of fostering successful digital education and training.

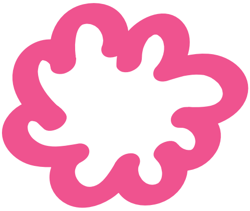
Despite the widespread presence of digital transformation and technology in our daily lives, there remains a significant gap in the digital skills possessed by many individuals, hindering their participation in today's society and economy. The COVID-19 pandemic has highlighted the consequences of insufficient digital skills, leading to exacerbated inequalities and potential negative effects on personal well-being and mental health. Additionally, emerging technologies like generative artificial intelligence present both opportunities and risks, emphasising the importance of digital skills in harnessing their potential. There is a rising demand for basic digital skills, the emergence of new specialised digital skills, and a shortage of ICT specialists across various sectors and occupations.

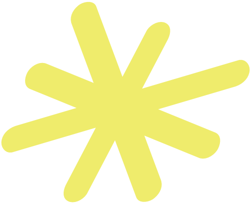
The ongoing digital transformation necessitates adaptive education and training systems that cater to the evolving learning needs of individuals in a rapidly changing technological landscape. Insufficient provision of digital skills in education and training has been identified as a primary cause of underachievement, as evidenced by long-term research and stakeholder consultations. Early childhood education and care (ECEC) are pivotal in cultivating active citizenship and learning among children. Research indicates that children are increasingly engaging with digital technologies from a young age, mostly at home, emulating adult behaviour with a trial-and-error approach that carries inherent risks.

Digitally competent ECEC professionals can assist children and families in developing safe technology interaction skills, while promoting equal opportunities. In formal education (primary and secondary), digital skills are fostered through diverse methods. Many Member States have recently revised or are currently evaluating their curricula, with approximately half of the reforms being transversal in nature and about a third focusing on specific subject areas.

Although this document has a specific focus on the relevance of digital abilities in the Year of Skills; the Action plan rarely mentions scientific skills to raise a scientifically digitally literate society. However, the few citations of science indicates an opportunity to rethink about open schooling strategies for policy makers. The alignment of digital and scientific skills underpinned by open schooling from the recent document "The EU COUNCIL RECOMMENDATION on improving the provision of digital skills in education and training" should be considered. As the document highlights, the inclusion of digital skills across various subjects in the curriculum helps engage more teachers and students. However, recent studies suggest that teaching digital skills as a separate subject, such as informatics, is becoming a common trend. Implementation methods vary, often starting at the secondary level and being partially optional, which limits access for all students. Some countries integrate digital skills or informatics into existing subjects like mathematics or science to improve educational effectiveness. To ensure successful implementation, a dedicated curriculum for digital skills requires digitally competent teachers who can understand, endorse, deliver, support, and assess it.

Challenges include ensuring quality teaching, relevant resources, gender balance, and proper assessment. Encouraging enrolment in advanced digital skill development programs, especially for women, and promoting dual degree tracks that combine digital skills with other disciplines are essential.





2023 European Year of Skills supported by open schooling

The “2023 European Year of Skills” is a designated year in which the European Union focuses on promoting and developing skills among all members of society. The initiative aims to raise awareness about the importance of skills in the context of employment, economic growth, and social inclusion.

The skills covered in each of the open-schooling resources in CONNECT is shown in the table below.

Resource & Disciplines	Inquiry skills UK, 2023	Green skills Okada & Gray, 2023	RRI skills	Digital Skills
REWILDING *Biology, Geography, ICT and Languages*	Weigh evidence for conclusions. Write coherently.	Biodiversity Respect for life and environment Systems thinking Socio-scientific argumentation	Drawing conclusions with scientific, ethical, legal, and social reasoning	Digital content creation
MICROPLASTICS *Chemistry, Biology, ICT and Maths*	Choose an appropriate method Make sense of text.	Circular economy - no pollution Respect for life and environment Problem solving Critical Thinking	Method definition	Problem solving Information and data literacy
CARBON NEUTRAL *Chemistry, ICT and Maths*	Make hypotheses or claim Explain ideas orally.	Climate change decarbonisation Respect for life and environment Decision-making Socio-scientific argumentation	Communication skills	Problem solving Communication
ENERGY SAVERS *Physics, Arts, ICT and Maths*	Represent with models Explain ideas orally.	STEAM in real-life Respect for life and environment Problem-solving/	Communication skills	Problem solving Communication
CAR WARS 2030 *Chemistry, ICT and Languages*	Consider different perspectives. Make sense of text.	Climate change decarbonisation Respect for life and environment Critical thinking Decision-making	Engagement’ skills	Problem solving Collaboration

Table 4: CONNECT Resources and skills.

Open scenarios: Education for Democracy

Take care of the Earth
Take care of each other
WHAT WE SAVE
ESS PLASTIK MORE PLANET
SAVE OVER PLANET EARTH it's The onLyone we HAVE

The open-ended scenarios are underpinned by participatory methods for open schooling. This novel approach stimulates students' interest in science through a societal and action-oriented perspective. Through these methods, science is understood in the context of the surrounding society, as the focus is on real, locally relevant challenges that are decided upon by the students or local actors from their community. Students learn to build and navigate relevant knowledge, applying it to develop holistic solutions that are well-informed, knowledge-based, and originate from societal needs and values. This process has proven to be highly motivating for students.

In these open-ended scenarios, the primary aim is not to follow the scientific method strictly but to engage students in participatory decision-making processes. Students utilise knowledge acquired through scientific methods when addressing the local challenges, they're exploring and in their dialogues with scientists. The objective is to familiarise students with participatory methods, aiding them in problem assessment and decision-making based on scientific evidence as well as experiential knowledge.

These open-ended scenarios are crafted to involve various participants throughout the process. Students have the opportunity to engage with a broad spectrum of relevant experts, family members, and decision-makers. This interaction allows them to understand the nexus between science, local community challenges, and decision-making processes.

As students' progress through the open-ended scenarios, they embark on a journey of identifying a local challenge, establishing a knowledge base, interacting with experts, and finally, crafting holistic solutions.

Each method within the open-ended scenario can be implemented in both regular school lessons and extracurricular activities. As a novel approach, these scenarios invite experimentation from teachers seeking fresh methods and willing to engage their local community in the learning process.

Each method is structured according to the framework of open-ended scenarios, constructed around the various stages of a participatory process. Beginning with the identification and formulation of a challenge, progressing to the creation of a shared knowledge base and fosters dialogue, ultimately leading to the proposition of potential action points.

Methods for Open Schooling and related references	ENGAGE2020 Catalogue	Number of lessons
Jury	Citizen Juries	10 to 12
Consensus	Consensus Conference	5 to 10
Co-creation	World Café, Participatory Design	5 to 10
System-oriented dialogue model	Participatory Action Research	5 to 10
Inquiry Mapping	Deliberative Mapping	3 to 5
Collaborative project-based learning	Flow Map	3 to 5

Table 5: Open-ended Scenario Framework.

The Danish Board of Technology has adapted three participatory methods for open-ended scenarios from the EU Catalogue ENGAGE2020 widely used in Responsible Research and Innovation for public engagement. These methods are the Citizen Jury, Consensus Conference, and Co-creation.

In addition, three partners in the Spain (IRSICAIXA), UK(OU), and Brazil (PUC-PR) developed three methods respectively System-oriented dialogue model, Inquiry Mapping, and Collaborative project-based learning.

Each method draws from years of experience in developing and implementing participatory processes. These methods have been further tailored to suit an open schooling context, informed by inputs from the CONNECT project partners and the CONNECT User Advisory Board, all of which comprise professionals experienced in the fields of science education and open schooling. Detailed introductions of these three methods follow in the subsequent sections.

Participatory and Responsive Science Education

This is a bottom-up approach to developing scenarios, which will emerge from the ideas and negotiations between the Consortium University, research lab, company, and CSO – Civil Society Organisations – with schools and families about a relevant local issue. We will only provide project guidelines, to explain and simplify the principles of public engagement, policy development (e.g. 'mini deliberations') and agile methods, which we want partners to use in identifying and addressing local issues where science knowledge has a natural role to play. The issues could be identified by the school, the science professional, the family, or other local community players. It is up to the partners to develop and apply criteria for selecting the topic and activities to develop with the support of local council and existing contacts of CONNECT consortium. Universities and enterprise partners will supply scientific experts "on demand" to interact with the school, provide data or information and support students' deliberations on the issue.

Science action stage	Learning objective	Steps	Methods	Participants
Care	To develop engagement and interest by framing and finding approach to community-based challenge	Framing	**1.** Agenda setting	Students Experts / Scientists Local community Families
		Questions	**2.** Inquiry Mapping	
Know	to acquire scientific understanding of local issues and problem-solving approaches supported by research and interactions with scientists and citizens, to develop alternative solutions together	Knowledge & opinions	**3.** Desktop research, **4.** Interviews **5.** Informed survey, and **6.** Stakeholder analysis	Students Experts / Scientists Local community Teacher Advisors
		Deliberation	**7.** System-oriented dialogue model **8.** Consensus format, **9.** Jury format, **10.** Co-creation	Fellow students Experts / Scientists Local community Teacher
Do	To communicate science actions projects and findings to the local community	Recommendations Dissemination	**11.** Collaborative project based learning Open letter and Article	Students Experts
				Decision-makers Media Stakeholders

Table 6: Open Scenarios methods.

The open-ended scenarios are built upon a model of six steps, two for every stage of the CONNECT science action Care-Know-Do framework. Teachers will facilitate the process and guide the students through each step of the model, which has different options for choice of methods and participants.

The purpose of the model is to empower students by giving them an understanding of how to approach socio-scientific issues they experience in their local community.

Ideally the steps of the model are chosen based on the issue at hand. With inspiration from Engage2020 Action Catalogue the aim is to create a map from where the students can navigate and choose a fitting format for their chosen challenged.

Care: *Framing and Questions* – The first two steps are to identify and frame a challenge faced in the local community (Framing) and to find a way to approach this challenge (Questions). These steps can be carried out by the students, families, teachers, experts, or the local community.

Know: *Knowledge & Opinions and Deliberation* – The students gather knowledge on the challenge and map out different opinions and stakeholders through desk-top research and interviews with experts, scientists, stakeholders or the CONNECT User Advisory Board (Knowledge & Opinions).
Using elements from the participatory methods, consensus format, jury format, informed survey and co-creation, students will deliberate with local stakeholders, experts, follow students or the local community (Deliberation).

Do: *Recommendations and Dissemination* - based on the outcome of the deliberation step students formulate recommendations. These recommendations can be formulated by the students themselves or in collaboration with scientists or experts (Recommendations). The recommendations are presented to local policy makers, media, and stakeholders (Dissemination).

Methods

The CARE stage uses open-ended scenarios, inspired by participatory methods, to craft questions derived from real-life problems that are significant to both students and their communities. This stage includes two steps framing the problem and devising questions to encourages an active, immersive learning experience, where learners are directly involved in addressing issues that are relevant and meaningful to their lives. For each step two methods are presented respectively.

- **Agenda Setting:** agenda setting is about deciding which issues are important enough to deserve time and resources. It is an essential part of the policy-making process, shaping the direction and focus of government action.

- **Inquiry Mapping:** participants formulate and enhance queries related to real-world issues, drawing from pertinent documents, reflections, and observations in group settings (Okada, 2023; Okada et. al, 2020). These investigations are bolstered by expert-recommended references, for in-depth exploration. Students extract notable information from the selected documents, and pinpoint crucial insights and questions. They are encouraged to evaluate, link, and support evidence-based claims with convincing arguments and substantiating evidence. This iterative method assists students in formulating nuanced questions concerning real-life issues that have significant implications for them.

The KNOW stage involves participatory approaches for participants to delve into knowledge to tackle real-life problems including specific socio-scientific questions raised in the previous stage. The first step is knowledge & opinions with the recommended methods as follows. The students compile information related to the challenge.

- **Desktop Research:** This is a method where researchers investigate existing data and literature to gather information on a specific topic. Sources may include academic publications, online databases, government reports, statistics, and more. This approach provides a broad overview and context about the subject matter.
- **Interviews:** This technique involves one-on-one or group conversations where the researcher poses questions to gain deeper insights and perspectives from individuals who are knowledgeable about the topic. The interviewee's experiences, opinions, and understanding can provide invaluable context to the problem or policy being considered.
- **Stakeholder Analysis:** This is a systematic approach to identifying and evaluating the influence and interest of people or organisations (stakeholders) who have a vested interest in the problem or policy. This process is crucial in understanding the different perspectives and potential impacts of a decision, thereby ensuring that policy formulation and problem-solving approaches are well-informed, balanced, and fair.

The second step is deliberation for participants to identify various perspectives with experts, scientists, and other stakeholders, This step can be performed through one of these four comprehensive methods:

- **System-oriented dialogue model** is a participatory action-research process for reaching consensus on integral solutions of complex problems involving teachers, students, their families, STEM professionals and other stakeholders. It combines different approaches, the Care-Know-Do methodological framework, the stages of the "Dialogue Model" and "system analysis" to understand the complexity of the challenge. This System emphasises the experiential knowledge of students, families, and teachers, utilising a methodology that explores problem complexity and integrates multiple perspectives and solutions.

- **Consensus Conference** – involves a random group of 10-30 citizens. They receive information about a specific topic, create questions, consult various experts, and then formulate recommendations. These insights are then presented to policymakers, stakeholders, experts, and the media for further consideration and action. This process is part of the Engage2020 Action Catalogue.

- **Jury** – A group of 12-25 randomly chosen citizens, all directly impacted by the pertinent issue, is tasked with reaching a unified decision and crafting recommendations. They're educated about the issue, engage with experts for consultation, and develop recommendations. These suggestions are then presented to the appropriate governmental body, often at a local or regional level. This procedure is featured in the Engage2020 Action Catalogue.

- **Informed Survey** – aims to gather insights about societal values, needs, and concerns by targeting a broad spectrum of citizens. This approach serves as a valuable source of input for shaping recommendations. It requires a comprehensive introduction and explanation of the issue at hand to the participants. This method, utilised by the Human Brain Project, is not yet included in the Engage2020 Action Catalogue.

- **Co-creation** is a collaborative process where citizens initially formulate visions for a specific subject. These visions are then refined through various participatory stages involving citizens, stakeholders, policymakers, and experts, transforming into actionable items. Finally, these actions are prioritised and disseminated by stakeholders, policymakers, and experts. This method, utilised by CIMULACT, is not yet documented in the Engage2020 Action Catalogue.

Unlike the Jury Method and the Consensus Method for open schooling, where citizens critically assess information to make recommendations for action, the Co-creation Method involves citizens and other societal actors collaboratively participating in innovation processes.

In the "Do" phase, students, based on the results from their deliberation step, develop recommendations. They may do this either independently or in cooperation with scientists or experts. These suggestions are then communicated to local decision-makers, the media, and key stakeholders for consideration and potential action.

- **Collaborative Project based learning** – students, community-members work together in teams or groups aiming at developing an output, for example, open letter or an article to disseminate the recommendations or innovation-based output. They share ideas, divide tasks, and collaborate to solve a problem or complete the task by developing a project. Strategies are centred on the construction of knowledge through brainstorming and Design Thinking with the collaboration between participants.

STEPS

The open-ended scenario pilot combines six steps described as follows.

1. Framing

Discussion at home – Students will discuss challenges at home with their families – what challenges do they see in their local community, what bothers them, what could be better.

Student workshop – Based on these discussions at home the class will have a workshop facilitated by the teacher to decide on one local challenge they will be working with:

1. Students will write the challenges they have discussed at home on sticky notes and display them on the blackboard.
2. In collaboration the class will discuss and group the different challenges presented
3. The students will vote on the challenges and decide which challenge to work with

2. Questions

Groupwork – Students will formulate 3-5 overall questions defining what they would like to know about the challenge.

2 hours should be set aside for this step – for group work and collecting up in class.

3. Knowledge & Opinions

Groupwork - Students will do research, find information on the chosen challenge and map out possible solutions and different opinions through desk-top research and interviews with local stakeholders and experts. As a part of this process students will have to identify local stakeholders and experts in collaboration with the teacher as well as with support from the CONNECT database of STEM professionals, scientists and CONNECT Local User advisory board.

4. Deliberation

Preparation at home and in groups – Students will prepare questions for the local stakeholders and experts at home with their families and prioritise questions in groups.

Dialogue - The teacher will organise and facilitate an online or face-to-face meeting with 2-4 local stakeholders and experts. Students will ask their questions and discuss solutions.

Issues about no internet access or low internet connection must be discussed with CONNECT coaches and consortium implementation leaders.

5. Recommendations

Student workshop – Students will work in groups and come up with recommendations based on the deliberation, give feedback, and prioritise recommendations:

1. Groups will formulate recommendations by formulating their:
   - *Observations*
   - *Assessment*
   - *Recommendations*
2. Groups will go together two and two, one group will present their recommendations, the other group will give feedback and vice versa.
3. Groups will adjust their observations, assessment, recommendations based on feedback given
4. Class creates prioritised list of recommendations by voting
5. Dissemination: List of recommendations (including observations and assessments) will be sent as an open letter for town hall, the local newspaper, and relevant stakeholders.

Promoting students’ science capital

The Open-ended scenario has been set up to promote students’ science capital by following the CONNECT science action Care-Know-Do framework. The goal of the six steps is to empower the students by having them face a challenge they experience first-hand in their own community by gaining knowledge and skills to act upon this challenge.

Acquired skills:

Care	Know	Do
Understanding of and how to approach a local challenge	Research skills, understanding conflicts of interest, interact with experts, scientist, and local stakeholders, understanding of engagement methods	Formulate policy recommendations, understanding of policy levels.

Foundation of the Open-ended scenarios

Besides the participatory methods tailored for the open-ended scenarios, they also draw inspiration from the conceptual frameworks of Deliberative Democracy and Responsible Research and Innovation (RRI). This is further supplemented by years of experience developing and applying participatory methods across diverse contexts.

The subsequent sections outline key elements from Deliberative Democracy and RRI that have informed the design of the open-ended scenarios. Although both frameworks could be elaborated extensively, the focus here is on the aspects most relevant to understanding these scenarios. Following this, a brief overview connecting the scenarios to the Sustainable Development Goals will be provided.

Deliberative democracy represents a school of participatory approaches with the goal of positioning deliberation and dialogue at the heart of decision-making processes. Its objective is to generate sustainable solutions grounded in well-informed, democratic foundations. By involving citizens in these processes, a wealth of varied knowledge and viewpoints can be harnessed, leading to legitimate and enduring outcomes (The Danish Board of Technology).

Various participatory methods have been designed to achieve these outcomes, each tailored to address unique challenges, stages of the decision-making process, and anticipated results. However, all these methods share common criteria necessary for a legitimate deliberative process.

For example, the participant group should reflect societal diversity in terms of gender, age, education level, and ethnicity. This approach, aiming to reflect the broader society within the participant group, ensures the inclusion of all perspectives, particularly those from traditionally underrepresented groups (The Danish Board of Technology, OECD).

This inclusivity extends to different forms of knowledge, recognizing their importance in the decision-making process. Citizens contribute their personal knowledge and societal experiences, which hold intrinsic value for the process. Additionally, the deliberative process should foster a shared understanding of the challenge at hand, providing a foundation for discussion and recommendation development. It's crucial for citizens to encounter differing perspectives and opposing viewpoints from diverse disciplines and sectors, promoting a comprehensive understanding of the challenge. Furthermore, citizens should have a say in determining the experts they consult during the process (The Danish Board of Technology, OECD).

Creating space for structured dialogue among participants is paramount in deliberative processes. This encourages the digestion and comprehension of newly acquired knowledge, interpretation of this information, and application in the formulation of solutions that address varying interests and needs. Consequently, the process should be facilitated, ensuring that all participants can voice their opinions and exert an equal influence on the final outcome (The Danish Board of Technology, OECD).

Deliberative processes are, by nature, action-oriented. Their overarching aim is to feed into decision-making processes. Ideally, decision-makers should utilize the input provided to address the challenge at hand once the process concludes. A clear purpose and anticipated outcome from the onset are crucial for progressing towards tangible impact and action. Understanding the political uptake and commitment to the outcome is also essential. A defined political mandate and comprehension of how the outcome will be applied post-process are pivotal in motivating participants (The Danish Board of Technology, OECD).

Responsible Research and Innovation

The concept of the open-ended scenarios also stems from the tradition of Responsible Research and Innovation (RRI), a framework birthed from European research and innovation policy. RRI encompasses six key elements: gender, ethics, governance, open access, science education, and public engagement. Notably, the public engagement element has exerted significant influence on the development of the open-ended scenarios.

RRI's primary goal is to widen the scope of research and innovation (R&I) and build a more robust link to society. It achieves this by incorporating interdisciplinary approaches and placing a keen emphasis on social, environmental, and economic factors when addressing specific challenges. RRI thus encapsulates the idea that by engaging diverse societal actors in R&I activities, the broader implications and societal consequences of these activities and their outcomes can be more effectively considered (von Schomberg 2011). By involving society, R&I becomes more legitimate, aligning more closely with societal desires and acceptability (von Schomberg 2011).

Furthermore, RRI aims to build reciprocal responsiveness, leading to socially desirable R&I outcomes while also enhancing society's ability to participate in and share responsibility for R&I activities and the application of their results (von Schomberg 2011). An additional objective of RRI is to bridge the gap between R&I and policy-making processes, fostering robust, well-informed decision-making processes anchored in scientific knowledge and rigorous analysis (von Schomberg 2011).

The Sustainable Development Goals

While the open-ended scenarios are not expressly constructed on the Sustainable Development Goals (SDGs), they bear significant relevance to Goal 16: Peace, Justice, and Strong Institutions, and Goal 17: Partnerships for the Goals.Specifically, sub-goal 16.6 aims to develop "transparent institutions at all levels", while sub-goal 16.7 seeks to "ensure responsive, inclusive, participatory and representative decision-making at all levels" (SDGs 16). Similarly, sub-goal 17.16 endeavors to establish robust "multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology, and financial resources". Moreover, sub-goal 17.17 encourages and promotes effective public, public-private, and civil society partnerships" (SDGs 17).

These participatory processes inherently seek to foster responsive, participatory, and representative decision-making processes, consequently contributing to more transparent institutions. Furthermore, the emphasis on public engagement in RRI also aims to cultivate more responsive R&I by building on multi-stakeholder partnerships, fostering stronger sector collaboration, creating responsive solutions, and enhancing transparency within R&I institutions.

Through these open-ended scenarios, students learn about responsive, inclusive, participatory, and representative processes as they master the skills of navigating and integrating different forms of knowledge. They grasp the context of scientific knowledge within society and utilize it to create socially desirable solutions. They gain an understanding of the interplay between science, local challenges, and decision-making processes, fostering their comprehension of transparent institutions and the benefits of cross-sector collaboration.

Besides Goals 16 and 17, the open-ended scenarios can also connect to other SDGs depending on the specific topic chosen by the students.

Applying the foundations to open schooling

The objective of the open-ended scenarios is to integrate the principles of deliberative democracy and Responsible Research and Innovation (RRI) within the realm of open schooling via participatory processes. The overarching goal of this innovative approach is to refresh science education, engaging a broad spectrum of students, particularly those who typically show less interest in traditional science education.

By grappling with current, pertinent societal issues, understanding these issues through a scientific lens, and applying their knowledge to develop responsive and comprehensive solutions, students' interest in science and its potential can be stimulated. Thus, science is contextualised within the students' interests and motivations in their own society. A key aspect of the open-ended scenarios is to involve students in the initial stage of the process, letting them identify a local challenge to study and ensure their engagement.

This process also involves rethinking the conventional approach to knowledge acquisition. Instead of learning various skills to be applied later to societal challenges, students learn to gather pertinent knowledge and apply it within the context of the specific challenge they're addressing. Furthermore, they learn to assemble knowledge from different perspectives and utilise it to devise responsive solutions. This shift moves students from passive education to active participation, imparting an understanding of the interconnectedness between their school learning (science), their local community (challenges and local knowledge), and local decision-making processes. This helps students comprehend how science and decision-making can be responsive to society's challenges and priorities through active participation.

The open-ended scenarios are adaptations of participatory processes, incorporating elements of deliberative democracy and RRI, with necessary adjustments for optimal educational outcomes. These scenarios were developed based on participatory methods and adhere as closely to these methods as possible, with some compromises made to accommodate the context of open schooling.
For example, in some schools, the student composition may reflect the diversity of the surrounding society, with students hailing from families with various educational and ethnic backgrounds. In contrast, in other contexts, the student composition may lack such diversity, compromising the aspect of representation. Therefore, the development of open-ended scenarios required striking a balance between adhering closely to the adapted participatory methods and adjusting to the open schooling context, resulting in a process that is both educational and implementable in this context. Particularly since this is an innovative model and an experiment, the onus is also on individual teachers to devise a process that suits their specific educational context.

To support the further use and implementation of the open-ended scenarios, four guiding principles have been developed based on the aforementioned elements and the experiences from implementing the open-ended scenarios.

Guiding principles for implementing the open-ended scenarios

Four guiding principles have been formulated to provide direction for the implementation of open-ended scenarios. They elucidate the foundational aspects of these processes, enhancing understanding of the purpose, aim, and goals of the open-ended scenarios. As these scenarios represent a novel and experimental approach, they are designed to be adaptable and open to further experimentation. Consequently, there are no hard-and-fast rules or minimum requirements associated with employing an open-ended scenario method. However, the underlying purpose of this approach should be kept in mind when implementing the methods. The following four guiding principles form the bedrock of the method and can serve as a navigational tool for customising the process, if necessary. Like the open-ended scenarios themselves, the guiding principles draw their origins from the participatory methods adapted for the open-ended scenarios, as well as Deliberative Democracy and Responsible Research and Innovation. They also maintain a connection with the Sustainable Development Goals. It's important to view all four principles as interconnected.

Knowledge: The process and its outcomes should pivot on a common, well-informed, and knowledge-based foundation that embraces various forms of knowledge, perspectives, and viewpoints. This implies that the societal challenge under consideration should guide the knowledge gathering process, rather than the reverse. This involves:

- Incorporating knowledge from diverse scientific disciplines.
- Including diverse, and potentially conflicting, perspectives.
- Recognizing various forms of knowledge, thus incorporating expertise from beyond the academic sphere - experts are not solely found in universities.
- Allowing the societal challenge at hand to steer the kinds of knowledge and perspectives incorporated into the process.
- Maintaining an open-minded stance, willing to investigate new avenues that may emerge during the exploration of the societal challenge.
- Allotting sufficient time for understanding, absorbing, and debating the collected information.

Diversity: Inclusion of a diverse participant group in the process is paramount. This group will employ the knowledge gathered to create solutions responsive to societal needs and reflective of varied societal interests. To establish a democratic and representative process, it's vital that all participants have equal influence on the process and its outcomes. Students and family members may well represent the local community. This means:

- Reflection on aspects such as gender, ethnicity, and parents' educational backgrounds, considering how these factors may influence the process.
- Ensuring that each participant has an equal voice in the process and its outcomes, regardless of their diverse backgrounds.
- If feasible, forming groups that represent diversity in terms of the above criteria.

Action: The process should be designed to stimulate action on the societal challenge under scrutiny. The main objective of this process is to generate actionable solutions that relevant decision-makers can leverage to tackle the challenge. Consequently, the process isn't solely about understanding the problem, but also about utilising the gathered knowledge to devise concrete solutions. This means:

- Ensuring clarity of purpose from the outset.
- Aiming for outcomes that are action-oriented, manifesting as actionable recommendations or proposed solutions.
- Inviting local decision-makers early in the process to help secure political commitment.
- Engaging local media to raise awareness and amplify pressure for action.

Connection: The process fundamentally involves fostering a holistic understanding by transitioning from traditional education to active participation. The objective is to educate students about the links between local community challenges, academic knowledge (particularly science), and decision-making processes. This approach not only offers a holistic perspective of problems but also positions scientific understanding within the context of society and policy. It aims to engage students who might not be inspired by conventional science education methods, and to lay the groundwork for cultivating responsible approaches to science among our future scientists. This means:

- Ensuring that the process is rooted in knowledge, diversity, and action.
- Confirming that the selected challenge is locally relevant and meaningful to the students.

Community Engagement tools

Open Schooling is an approach to science education that involves active participation from various entities such as schools, universities, enterprises, and society. The collaboration and partnership between these organisations are crucial to enhance the perception of science among young individuals and their families, ultimately leading to engaging and rewarding experiences for them. However, the current educational model, which is predominantly traditional and content-based, poses a challenge in promoting collaboration among students and other interested parties who wish to implement CONNECT activities. This challenge centres around how to proactively foster engagement led by students in using science to connect with citizens, entrepreneurs, family members, and other community stakeholders. To address this challenge and facilitate meaningful engagement, the CONNECT living lab IRSI Caixa has developed an Engagement Toolkit. This toolkit was created through an initial diagnosis analysis with CONNECT partners. This analysis focuses on partners' education communities and other stakeholders to consider their challenges and opportunities associated with participating in an Open Schooling project, particularly within the context of the pandemic. Through a comprehensive analysis, 21 clusters have been identified, encompassing a range of problems, opportunities, and solutions for schools and families. These clusters represent key issues that need to be addressed (Table1).

The identified challenges served as the foundation for CONNECT's endeavours to engage a significant number of schools and families. This set of potential challenges and benefits formed the basis for the Engagement Toolkit.

The Initial Diagnosis followed with a second ideation workshop carried out during a plenary online meeting with all Consortium members during April 2021. Firstly, participants were asked to reflect on causes and consequences of the previously identified clusters of problems and opportunities to engage schools and families. Secondly, they were encouraged to reflect on the following categories that should be addressed to overcome the problems and take advantage of the opportunities: Materials/protocols, values, and beliefs. Lastly, they reflected on types of activities that we could promote for a successful and sustainable engagement.

This ideation process was based on previously defined goals for engagement inspired by the EDGE tool, which is a self-assessment tool to evaluate your institution's support for public engagement that was developed by the National Coordinating Centre for Public Engagement (NCCPE).

Based on the results of this second ideation workshop, an internal analysis was conducted which led to the identification of the key aspects that we should address to promote engagement and the key solutions to put in place. The key aspects included recognition, tight curricula, meaningful learning, need for support, and new role of schools, inequalities, and process of change. In table 8 we describe these aspects and the key solutions that CONNECT can offer to address them.

Education community Including schoolteachers, school Head, science coordinator, school inspectors, policy makers, entities that produce or disseminate education resources, students and their families)	**Science community and other stakeholders** (Scientists; group leader and institution director; communication, outreach, and education department; policy makers and funding organisations; others)
Innovation Time Curricula Relevance of content Digitalization Accessibility of materials Access to research Support during implementation Teacher empowerment Collaboration teacher to teacher Collaboration with experts Covid-19 Dissemination Recognition Direct benefits for policy makers Inequalities Families' engagement Family empowerment Student motivation Interest in science careers Collaborative learning	Motivation Career development Access to resources Time Economy/Funding issues Covid-19 Benefits for scientists Benefits for institutions Scientists' skills Empowerment of institutions Outreach Materials Needs Visibility Alignment with career Accessibility to schools Policy makers related issues Promotion of citizen science Engaging at institutional level Collaboration

Table 7: Clusters of problems and opportunities for engaging in OS (Source D2.1).

KEY ASPECTS	Why is it so important?	How can CONNECT contribute to address it?
Recognition of schools and teachers	Promotion of schools and teachers (including early career educators) that innovate in education is highly valued by families, and especially when the innovation also contributes to solve community challenges.	CONNECT promotes innovation through open schooling engaging families and other stakeholders from the community in research and participatory science to solve local challenges.
Time constriction and tight curricula	The number of topics that curricula cover leaves limited space for engaging activities to enhance skills related with the scientific method, which are in turn key for students to feel confident to use science in life.	CONNECT science actions such as structured and open-ended scenarios promote enhanced development of skills linked with the scientific method, which are a key part of the curricula.
Meaningful learning	Teachers value learning through scientific method and believe that motivating students to become engaged citizen scientists with and for the community contributes to increase science capital and leads to better learning outcomes and increased interest in STEM careers.	CONNECT facilitates partnerships to engage families, communities, and scientists in science projects in schools that address community challenges using real data and increase students and families' interest in science and STEM careers, which is key for achieving learning outcomes.
Partners to support education	Some teachers think that implementing changes in science education is difficult for a single teacher acting on its own.	CONNECT participants will benefit from partners supporting education: Teachers acting as coachers of other teachers to provide support during the process. Researchers becoming partners to provide students a role model and real data. Families getting involved in the learning process as a key for achieving the learning outcomes. Policy makers being targeted to ensure sustainability
New role of schools and science in community	Some people think that science is distant and not relevant for society. Science can be considered an academic subject with no direct implications in daily life.	CONNECT promotes collaboration with the community to contribute to local challenges, that could help to demystify the idea that science is distant and could contribute to increase students' and family's perception of science being socially relevant.

KEY ASPECTS	Why is it so important?	How can CONNECT contribute to address it?
Inequalities	Inequalities among students coming from low-income families lead to disadvantaged students that lack motivation towards science learning. Digital inequalities and other basic needs coverage should be addressed to assure a successful learning experience. Motivation towards STEM careers should be promoted for all students equally.	The CONNECT Engagement plan offers a tool for schools to design an Action Plan to apply changes in science education which includes targeting charities to diminish inequalities. Open-ended scenarios and the CKD framework can be used to create science-actions to fight against inequalities, such as crowdfunding campaigns to obtain digital resources for disadvantaged students.
Process of change	Implementing a change such as becoming an OS is a process which requires resources (materials, protocols) but also values and beliefs. A deep reflection process is required to design and implement an Action Plan for successfully change to implement CONNECT.	CONNECT offers an Engagement Action Plan that will guide and support teachers and schools willing to make changes in science education.

Table 8: Key aspects to be addressed for engaging of schools and families.

Our **recommendation** is to highlight these benefits.

School Heads/science coordinators: they can contribute to make their school more inclusive and accessible, increasing the capabilities and motivation towards science careers for all students equally. With CONNECT they can also obtain an open badge that could recognize the school as an educational center involved in open schooling and innovation, which could be highly appreciated by the schools' families. The schools can gain visibility and motivate other schools to implement similar actions.

Education inspectors/Education counsellors: they can contribute with solutions with the support of the Education Department of the local government. Can act as referrals, by recommending CONNECT to other schools.

Teachers: they can access curriculum-linked and ready-to-use educational resources that they can use in their science classes to improve the learning process and avoid the "science is not for me" effect. Can also share their experiences with other teachers around the world implementing science-actions throughout the CONNECT platform. Can contribute to the students' engagement and involvement by promoting OS activities in collaboration with scientists, families and other stakeholders.

Families: they have the opportunity to be involved in the students' science education, stimulating a shared interest in science and future careers.

Students: they can give their perspectives to improve their learning experience. Can also contribute to solve community challenges and experience how science can have a direct impact in their daily life. CONNECT activities (i.e., the approach to real-issues through science, the interaction with scientists) can have an important role to increase the awareness of science careers.

Scientists/STEM professionals, enterprises, and other stakeholders: they can experience personal and professional fulfilment and increase motivation by sharing their knowledge and passion with young people while raising awareness about their job.

Civil society organisations (CSOs): they can raise awareness within their community about their activity and improve how they solve real-problems by involving students, families and other stakeholders.

Policy makers and funding organisations: they can benefit from co-created knowledge, lessons learned and recommendations to improve their policies and priorities to contribute to solve the real needs of the community and/or education.

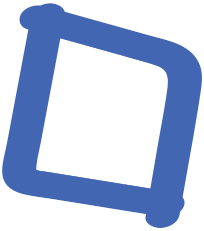
Editorials/entities that produce or disseminate educational resources: can contribute to creating resources that better align with schools' needs. To engage with national partners who are not educational institutions, it is recommended to collaborate with a community education partner who can assist in reaching out to schools and disseminating activities. Conducting a stakeholder analysis using a visual thinking tool is recommended to identify key stakeholders who can support engagement efforts. This analysis should include stakeholders from the education and research communities, as well as innovators in various system areas (education, social, economic, institutional, technology, research, and innovation). Additionally, stakeholders relevant to the specific challenges addressed by the educational resources should be considered.

Creation of a local and/or national User Advisory Board (UAB): it aims to support the implementation of the project and the Engagement Action Plan. The Board should include diversity of stakeholders relevant for the community.

Emailing and webinar presentations: shall be performed to present CONNECT at community level during the awareness phase of the three years of implementation of the project.

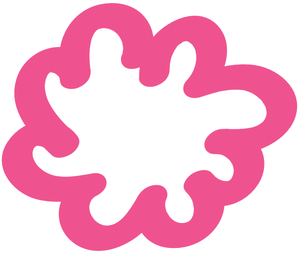
Additionally, during the second and the third year we recommend schools to offer workshops and webinars:

Workshops to reflect on problems and opportunities related to OS: aims to stimulate interest in OS and in the project and find strategies to overcome those barriers that teachers may find during the implementation phase.



Workshops for brainstorming on future visions of schools: Where OS approaches where the "science is not for me" is not a problem anymore.

Webinars related to OS to specific social challenges: The format and diversity of stakeholders are flexible, but the involvement of teachers, scientists and students is highly recommended. In order to previously identify challenges where schools are going to focus their work, national partners can launch surveys. They can also encourage schools to explore the community needs before they decide on the priority challenges.



Educational Partnerships

In the context of postmodern approaches in education and training, the term “educational partnership” has acquired new meanings, determined, on one hand, by the multiplication of social factors directly or indirectly interested in the life and activity of school institutions and, on another hand, by social awareness of the need for collaboration between the school and other educational agents, for the benefit of students.

According to (Vrăşmaş, 2008) “the educational partnership takes place permanently and together with the educational act itself”, having “the principle of value in pedagogy” and in education in general.

Within the CONNECT Project, the partnership was designed to regulate the relations of collaboration between the CONNECT consortium, represented by the institutions with the role of national coordinator and the pre-university education institutions, as formal / official representatives of teachers, students and, by extension, their parents. The model of Partnership Agreement, agreed within the CONNECT project, includes the following structural aspects:

1. Identification data of the partner institutions.
2. What is CONNECT and what is it aimed at?
3. What does CONNECT offer?
4. What will the school and teachers obtain from CONNECT and what will they be requested?
5. Clauses of the agreement.
6. Period covered by the agreement.
7. Final provisions.
8. Signatures of the legal representatives of the partner institutions.

The partnership agreement provides a comprehensive picture of the activities that will take place in this context, of the objectives pursued and of the responsibilities of each partner.

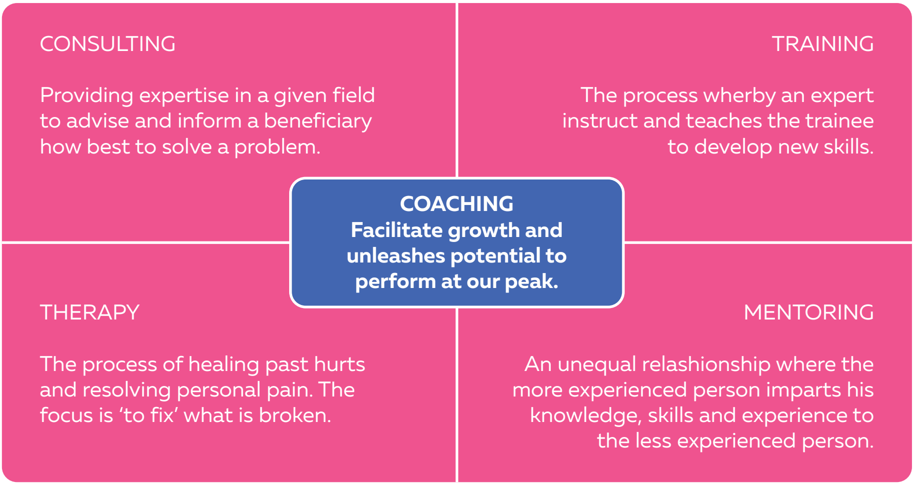
The Cooperation Agreement provides an officially regulated context for the development of activities within the CONNECT project, especially those aimed at coaching, the actual implementation of Science Actions (through formal and non-formal activities), as well as the evaluation of activities.

Coaching for open schooling teachers

Two quotes from experts in coaching inspired the CONNECT team to bring methods used in various sectors such as business, communication and marking, computing and industry focused on professional development centres, “Coaching is unlocking a person’s potential to maximise their own performance. It is helping them to learn rather than teaching them” (Sir John Whitmore, pioneering coaching and Co-founder of Performance Consultants).

At the same time, *“coaching is partnering with clients in a thought-provoking and creative process that inspires them to maximise their personal and professional potential”* (International Coaching Federation, 2021).

Starting from these two definitions of coaching, as well as from the elements of theory and applications described in the previously developed material (D5.1 Guidelines for implementation report), within the CONNECT project, a series of coaching activities were carried out, in the stage of piloting Science Actions units.



CONSULTING

Providing expertise in a given field to advise and inform a beneficiary how best to solve a problem.

TRAINING

The process wherby an expert instruct and teaches the trainee to develop new skills.

COACHING
Facilitate growth and unleashes potential to perform at our peak.

THERAPY

The process of healing past hurts and resolving personal pain. The focus is ‘to fix’ what is broken.

MENTORING

An unequal relashionship where the more experienced person imparts his knowledge, skills and experience to the less experienced person.

Figure 12: Coaching approach.

In this sense, a series of meetings were organised, generally in online format due to the pandemic, attended by teachers from pre-university education and coaches (science specialists, education scientists and researchers) from the institutions with the role of national coordinator. During these meetings, the teachers from pre-university education were supported, guided, advised, from a scientific and methodological point of view, to be able to effectively implement the Science Actions units / scenarios, at the level of the classes and students they coordinate.

At the same time, the materials and working tools were presented and analysed, in order to use them properly, in accordance with the philosophy of the CONNECT project, but also with the characteristics of students, related to age, social / community background, their previous knowledge, concerns and their interests in science, in general, and in the scientific issues addressed in Science Actions, in particular.

For many teachers, open schooling is a new pedagogy so it is unsurprising that they will need support in delivering open schooling activities. Data from the CONNECT teacher questionnaire highlighted aspects of open schooling where teachers were least confident.

Coaching from experts would be of benefit in these areas:Teaching scientific inquiry with real-life problems (29% with very little confidence, little confidence or only confident about some parts), promoting science learning activities beyond the school curriculum (30%) and discussing with students the learning goals that includes scientists (28%).

One aim of the project is to move teachers from novice to open schooling expert teachers. This involves, for many, big change in teaching style - to move from a dispenser of knowledge to a knowledge broker between students and scientists within society; to lift students from passive listeners to active learners, empowered to use science to transform their lives and the world. Coaching would be of benefit to help teachers transform their classroom practice in this way. Coaching is not just useful for teaching pedagogy to teachers embarking on open schooling projects, but also teacher educators. Plus, it can be used to guide other stakeholders in implementing strategies for engagement, evaluation, instructing policy and curriculum design.

A Coaching Model serves as a framework for conducting coaching sessions, providing a holistic understanding of the coaching process for both the coach and the client. However, it is important to note that a coaching model should not be rigid or overly prescriptive. The nature of coaching is centred around the client, and the conversation and approach should always be tailored to their needs (Chhibar, 2019). There are some coaching models, including internationally recognized examples that have been widely adopted as best practices in coaching. These are described as follows.

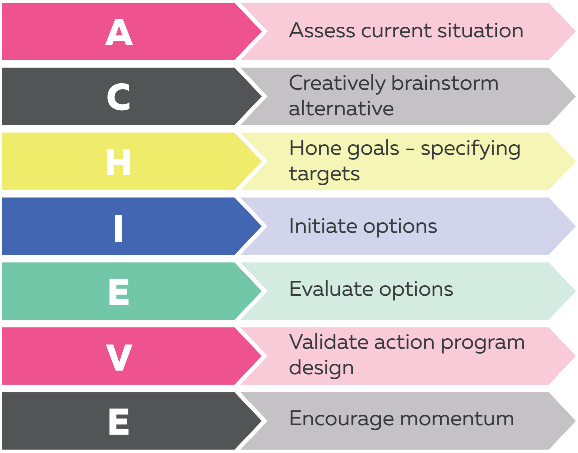

A
Assess current situation
C
Creatively brainstorm alternative
H
Hone goals - specifying targets
I
Initiate options
E
Evaluate options
V
Validate action program design
E
Encourage momentum

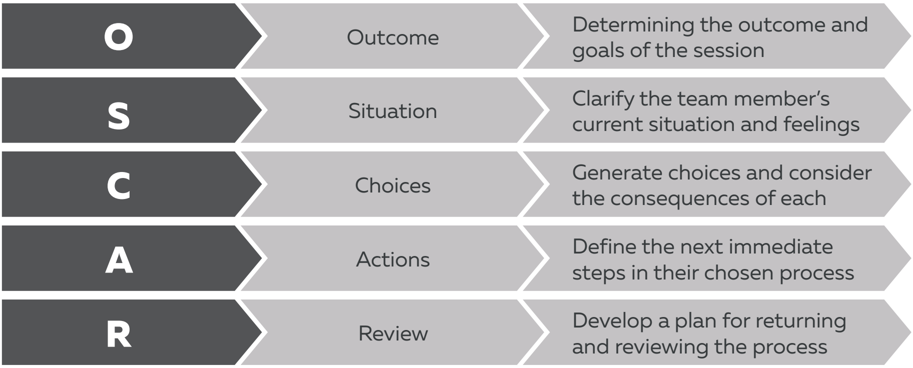
Figure 13: Coaching approach – ACHIEVE.

ACHIEVE model contains seven components.

Assess the current situation.

The catalyst for the start of coaching can be, for example, a clearly defined need for development, the desire to continue one's personal development, the desire for faster and more serious progress or dissatisfaction with the current situation. In terms of a teacher embarking on an open schooling project in this stage the coach could talk through the things the teacher wants to improve in their classroom e.g. lack of motivation, students weakness in certain skills.

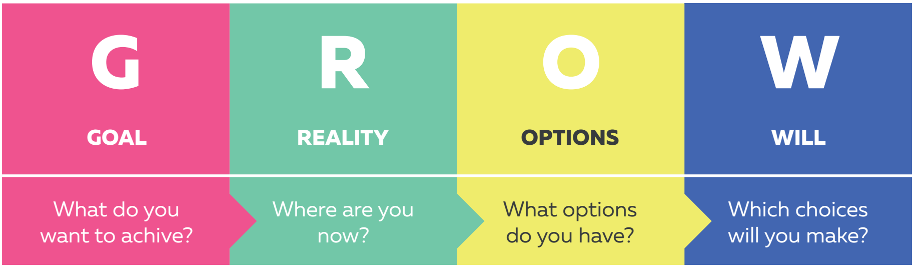
Creatively brainstorm alternatives.	This step aims to improve the prospects of the client and formulate a solid basis for creative solutions and behaviour change. In this stage the coach can introduce how open schooling can help improve the issues discussed in the Assess stage.
Hone goals - specifying targets.	The coach can create a complete picture of the goal, as it will look when it is reached so that the beneficiary can see if this is what he really wants.
Initiate options.	At this stage, the objective is to create a wide variety of different ways to achieve the objective. The coach should establish a creative atmosphere. Here the teacher and coach work together to plan the open schooling project.
Evaluate options.	An analysis of risks, constraints, or difficulties in the implementation of the earlier established goals. The teacher can raise any potential problems they can see when implementing the project, and the coach can help them problem-solve.
Valid action program design.	Specific activities are drafted, which will contribute to achieving the goal. The teacher and coach should work together to create a clear plan on how the project will be carried out.
Encourage momentum.	This stage consists of assisting the client on the determined objectives, affirmative action, appreciating results and reviewing progress. The coach and teachers should evaluate the project at the end, and discuss what worked well and what didn’t.



O	Outcome	Determining the outcome and goals of the session
S	Situation	Clarify the team member's current situation and feelings
C	Choices	Generate choices and consider the consequences of each
A	Actions	Define the next immediate steps in their chosen process
R	Review	Develop a plan for returning and reviewing the process

Figure 14: Coaching approach – OSCAR.

OSCAR is an acronym derived from the initials of the five phases of the coaching process. It is a model used mainly in focused solution coaching. It would be very useful in guiding a novice teacher through their first use of an open schooling project, where the coach can meet with them at several times along the journey of planning, implementing and evaluating.



G **GOAL**	**R** **REALITY**	**O** **OPTIONS**	**W** **WILL**
What do you want to achive?	Where are you now?	What options do you have?	Which choices will you make?

Figure 15: Coaching approach – GROW.

GROW is an acronym for **G**oal, current **R**eality, **O**ptions (or Obstacles) and **W**ill. Each of these elements can be carried alongside a series of questions by which the coach helps the client to address the problem they are facing.

Some of these possible questions that a coach could ask a teacher embarking on an open-schooling project are illustrated as follows.

Goal	What would you like to achieve as a result of the project? How will you know you've achieved your goal?
Reality	What have you done so far? What would you like to focus on first? What's the result you've reached? What stops you from moving on?
Options/Obstacles	What are the benefits? What are the difficulties? What exactly do you think would help you/what support do you need?
Will	How will you achieve the goal? What are you going to do first? Do you think that action will bring the desired result? How involved are you in this action, on a scale of 1-10? What's next?

Lessons learned from coaching about open schooling

The presence of voluntary coaches with expertise in the CONNECT events was a positive aspect. These coaches were actively engaged and motivated to enhance their teaching practices, benefiting from the support of an international project team from the UK.

> *Coaches were all voluntary collaborators with expertise, who are participating in CONNECT events and interested in developing their practices in training teachers, supported by an international project team (UK).*

The positive aspect here is that teachers' professional experience was highly valued, especially in activities or projects related to Science education. Furthermore, their broader competences beyond subject knowledge were acknowledged and utilized, contributing to a well-rounded educational approach.

> *It valorised the professional experience of teachers and enabled the transversal competences: good communication and relationship skills, proactive, constructive, and supportive attitude, teamwork skills, open, flexible attitude to change and innovation (RO).*

The negative aspect identified was the difficulty in recruiting additional coaches due to the constraint of finding volunteers who had enough time to commit to the role. Identifying added value for coaches was seen as a crucial issue for all countries. In addition, applying selection criteria to obtaining recognised support of participating teachers enabled CONNECT team to identify those who could adapt Science Action Units to students' needs and the specificities of the community as well provide interviews which were useful for recruiting and training more coaches.

> *Disseminating best practices and clear procedures facilitated the coaches' work, and created a personal satisfaction for them (UK).*

Lessons learned from Scientists' and Families'

Findings from evaluation have indicated that family members play a key role with students in identifying obstacles, discussing opportunities, and contributing to decision-making. In parallel, scientists have contributed based on three different roles. First, they play a role in introducing real-world problems and/or engaging students in selecting relevant issues related to real-world problems that they care about for scientific actions. Second, some partners invite scientists to provide information and answer questions during the "KNOW" phase, when students work with teachers to apply curriculum content to their scientific actions. Third, scientists are involved at the end of the process during events to share students' scientific actions with families and the local community.

The CONNECT project website and platform showcase Open Schooling impactful transformation of learning supported by scientists and families in all countries. For example, the Romanian schools who worked with the science action rewilding, which involves protecting nature by reintroducing species to their environment included activities for parents and scientists to support and appreciate students' achievements

The Open Schooling in the semi-arid region of Brazil focused on web consensus conference, led by the NGO Anjos Digitais, involved various professionals in science and education, from different sectors, for example, social care, and health, many teachers, and a total of 300 students. The theme addressed gender equity, puberty, and violence against young girls, which have increased during and post-pandemic. This initiative involved campaigns for wellbeing and involved families and local communities of the schools participating in the project.

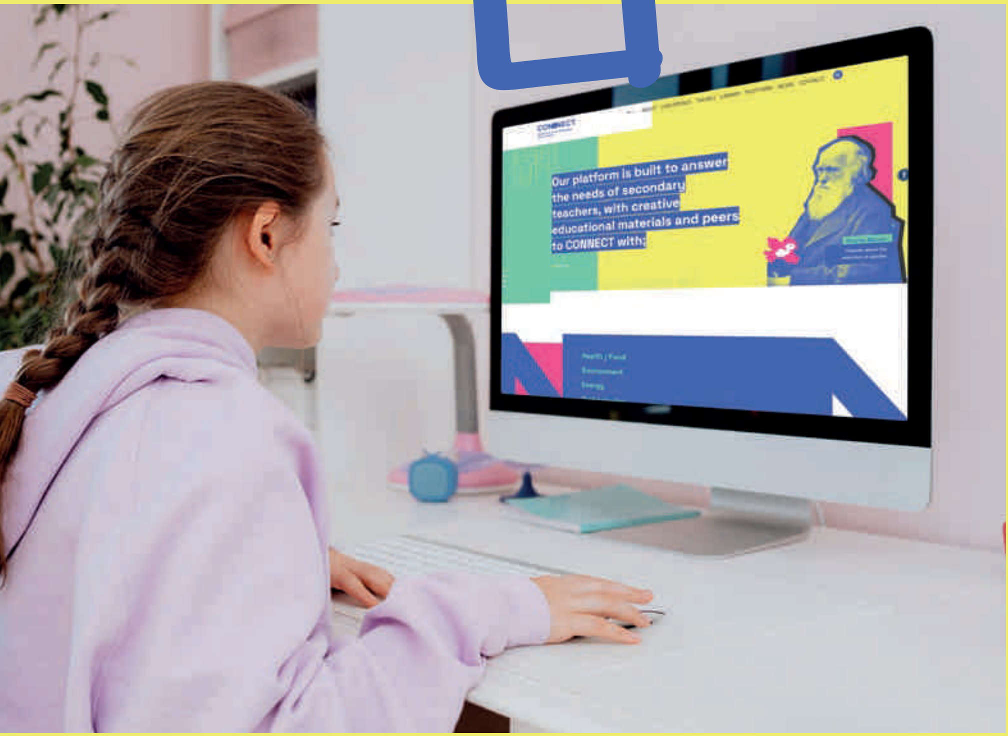
The Open Schooling final conferences in all countries involved large networks of schools, educational institutions, and over 100 visitors, including teachers, students, parents, scientists, citizens, and policy makers. The exhibitions provided a great opportunity to present the CONNECT activities to all practitioners. Some quotes from stakeholders illustrate the transformational impact for students' learning.

> *"It is an opportunity for us to develop our professional skills through 'direct' interaction with school students who provided great feedback about our work."*
>
> *Professional student in Medicine (Female), STEM ambassador Brazil*

> *"My daughter is now persuading people to stop smoking, explaining about lung and heart diseases using Augmented Reality. This is amazing."*
>
> *Family member – mother (Female), Brazil*

> *"The involvement of parents was evident in the entire class. I witnessed the students' progress in using evidence from various sources to support their claims. The presence of a scientist through Zoom added credibility to the project, and the students were actively engaged by it."*
>
> *Biology Educator (Female), UK*

Communication


CONNECT
Our platform is built to answer the needs of secondary teachers, with creative educational materials and peers to CONNECT with;
Health | Food
Environment
Energy

The CONNECT communication strategy supports the key aim of open schooling focused on fostering a scientifically literate society with more young students interested in science. To achieve this goal, informal learning, and non-formal learning through digital platforms play an important role not only as information providers but also as an environment to cultivate communication, partnerships and cooperation. CONNECT considers that "knowledge shared on the networks can result in a habitat of participatory science actions when exploited by a participatory architecture that activates it. In other words, the knowledge discussed, reflected upon, questioned, and expanded enables a better process of decision-making and improvement of practices supported by social media and social networks" (Meister & Okada, 2021).

The LOBA team led the open schooling habitat of collective intelligence supported by all CONNECT partners through a multi-channel integrated space, which includes the CONNECT website, Facebook, Twitter, YouTube, Instagram, LinkedIn, and newsletters. This habitat engaged many followers interested in open schooling, science education, high-quality learning resources, effective teaching materials, engaging participatory approaches, and science actions that enhance science aspirations. It aimed to connect students, scientists, and families in problem-solving towards a sustainable world, addressing real-world challenges for learning, research, and innovation in science.

The communication plan adopted two strategies at international and European levels in English Language; and at national and regional levels led by partners.

CONNECT established collaborations with key international and European partners:

- **EUSEA:** Online Meeting, Invited Talk, Knowledge exchange

- **ECSITE:** ECSITE annual conferences, OS Together network, Various inspiring sessions codesigned, multiple events, active collaboration on newsletters, and communication channels

- **ESHA European School Heads Association:** Through OS projects, participation in events, discussions in webinars, and conferences

- **IPA International Parents Association:** Through OS Together, participation in events, discussions in webinars, and conferences

Project outreach and partnerships

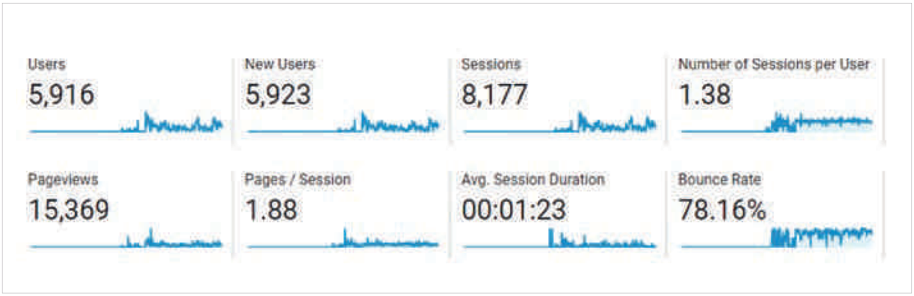
CONNECT also established collaborations with a large number of national organisations GO and NGo:

CONNECT partner leader	Partnerships established	Collaboration
OU, UNEB and APC-PUCPR	UNDIME, Secretary of Education in Municipalities and State Government	CONNECT in Brazil, established a partnership with local authorities to get their feedback, and also input in the Open Schooling Campaigns about Environmental protection
RDE	Local authorities	CONNECT in Greece
Romania	Local authorities	CONNECT in Romania
Spain	Escoles Sentinella EduCaixa	CONNECT in Spain
MS, and OU	Green Forum DfE GOV	CONNECT in UK

CONNECT in numbers (counting up to June 2023)

Connect Project EU Overview							
Social Media	**Posts**	**Followers**	**Reactions**	**Comments**	**Shares**	**Engagement**	**Reach**
Facebook	248	2,583	31,940	152	129	32,221	466,925
Instagram	76	62	7,872	3	11	7,886	652,214
Linkedin	242	145	470	3	38	511	11,644
Twitter	294	1,117	11,578	61	321	11,960	937,625
TOTAL	**860**	**3,907**	**51,860**	**219**	**499**	**52,578**	**2,068,408**

Website number of views (analytics)



Users
5,916

New Users
5,923

Sessions
8,177

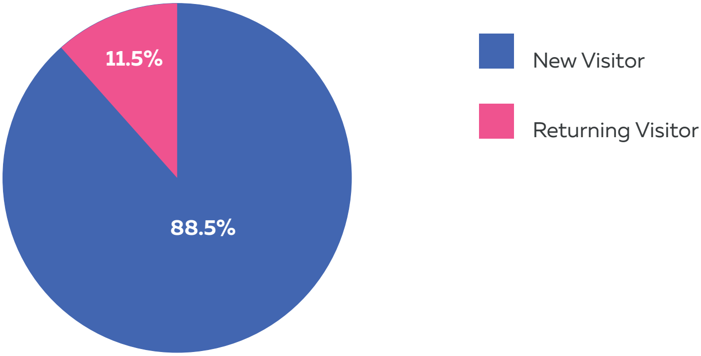
Number of Sessions per User
1.38

Pageviews
15,369

Pages / Session
1.88

Avg. Session Duration
00:01:23

Bounce Rate
78.16%



Open Schooling Together

Open
Schooling
together

Open Schooling together (OST) is a network established in December 2020 coordinated by ECSITE - European Network of Science Centres and Museums. OST includes eleven EU projects, whose aim is to promote collaboration among all projects to explore the Open Schooling approach for revolutionising the current traditional education by making them more meaningful to foster scientific literate. Each project aims to equip future citizens with the knowledge and skills necessary to navigate a rapidly changing world. To tackle these challenges, the network has developed innovative methodologies, guidelines, toolkits, platforms, and activities for teaching and learning that transcend the boundaries of traditional schooling and engage a diverse range of community stakeholders. By involving these stakeholders, students are empowered to see themselves as agents of change.

Period	Projects	Description	Goal
2019-2022	SEAS	*Science education for action and engagement towards sustainability.*	Advancement of scientific literacy for responsible citizenship.
2019-2022	PULCHRA	*Building participatory urban learning community hubs through research and activation.*	Strengthening science education through community partnerships "cities as urban ecosystems".
2019-2022	PHERECLOS	*Partnerships for pathways to higher education and science engagement in regional clusters of open schooling.*	Engagement of children and young people with academic research.
2019-2022	OSHub	*Open science hub network: empowering citizens through steam education with open schooling.*	Scientific education of communities for their sustainable development using RRI.
2020-2023	SALL	*Schools as living labs.*	Research and demonstration projects in outdoor spaces in food for sustainability contexts.
2020-2023	MOST	*Meaningful open schooling connects schools to communities.*	Partnerships to promote scientific competences with community projects from the environmental school.
2020-2023	Make it Open	*Make it open.*	Opening up of school learning through the education of doing (maker).
2020-2023	CONNECT	*Inclusive open schooling through engaging and future-oriented science.*	Formal and informal education with gamified scientific action in the curriculum and fun participatory science.
2021-2024	COSMOS	*Creating organisational structures for meaningful science education through open schooling for all.*	Creation of communities of practice (COP) on relevant socio-scientific issues.
2021-2024	MultiPlayers	*Multiplayers' partnerships to ensure meaningful engagement with science and research.*	Open scientific communities with open community events for data collection and decision-making processes.
2021-2024	Pafse	*Partnerships for science education*	Preparing communities to reduce the risk of communicable diseases and epidemics.

Table 9: Open Schooling Projects funded by the European Union.

Inclusive Open Schooling with engaging
and future-oriented science

CICOS2023
WELCOME!

The CONNECT International Conference on Open Schooling (CICOS 2023) was a scientific conference organized by the consortium of the CONNECT project, funded under the EU's research and innovation funding programme Horizon 2020. CICOS 2023 took place in the Museo de la Ciencia CosmoCaixa in Barcelona, Spain in July 2023.

The conference programme included renowned practitioners and researchers from all around the world to engage in a space for a critical exchange of knowledge and debate, stemming from the most recent innovations around Open Schooling educational practice.

CICOS2023 brought together academics, practitioners, experts, and learners:

- Researchers and policymakers working on R&I in education and in the challenges addressed through OS
- School heads willing to position their school as a change agent of their community through OS
- Non-formal educators from science museums and leisure and social services willing to increase their impact
- Teachers and students interested and/or practicing OS
- Support services, project managers and publishers developing, disseminating, and implementing OS educational resources

CICOS2023 had four objectives to ensure quality of education for sustainability:

1. Reflect and spread Open Schooling practices.
2. Overcome barriers with drivers that enhance the quality of education through Open Schooling.
3. Explore opportunities for Open Schooling to contribute to the sustainable development goals.
4. Enhance the sustainability and consolidate the Open Schooling movement in Education at local and global levels, through active cross-projects collaboration.

Participation Beyond CICOS2023

The CICOS2023 encompassed invited keynote presentations, parallel sessions, workshops, open discussions as well as poster presentations. We discussed how we can build on what we have achieved and how we can use evidence from our projects' evaluation to move forward.

The conference covered all topics in the broad ranges of Open Schooling in STEAM education.

1. Inclusion, democracy, and equity supported in OS.
2. Participatory methodologies for teamworking with researchers & other stakeholders.
3. OS supporting arts, and socio-cultural awareness.
4. Ecosystem stability using OS methodology.
5. OS for societies' health, nutrition, and wellbeing.
6. Affordable and clean energy, materials science, and emerging technology for sustainable development.
7. OS for science careers in emerging Labour Markets.
8. OS for climate change and environment green digital transition.
9. OS practices that all students engaged with CARE-KNOW-DO, considering age, school level, gender, geographical locations.
10. OS education for rural communities and less well represented actors and territories.

CONNECT
CICOS2023 Proceedings

Open Schooling Declaration

SAVE THE
EARTH
NO
B

The Open Schooling Declaration – OSD is a worldwide effort to promote authentic learning with real-world problems solved by students with their communities and expert professionals for their life improvement and global sustainability.

Who is for?

OSD is addressed to governments and international organisations, education agencies and ministries, charities, universities, schools, STEM professionals, and third sector including museums and outdoor educations.

Twelve Principles

1. Open Schooling brings together schools, business professionals, university researchers, and civil society for authentic education.
2. Students discuss real-life problems and solutions with professionals and communities through participatory methods.
3. Real-world applications of science foster students' meaningful learning towards a deep understanding rather than superficial knowledge.
4. Families, experts, resources, and technologies help with personalised learning by considering students' individual learning needs.
5. Responsible Research and Innovation increase awareness of future-oriented careers to empower students as sustainability agents.
6. Students co-create knowledge and practice skills relevant to them with science, arts, and humanities curricula.
7. Open Schooling connects students with science for wellbeing and sustainability transforming education.
8. Students develop competences in authentic contexts using socioscientific thinking and interdisciplinary knowledge.
9. Open Schooling promotes curiosity, ownership, and citizenship, enabling students to act responsibly with responsive actions.
10. Open schooling partnerships are key for open democracy and social justice locally and globally.
11. Learning communities care about real-world issues, know their needs, and take action.
12. Open schooling helps students develop sense of belonging, enjoyment, and confidence in science for life.

Fourteen Recommendations

1. **Create sustainable research and innovation networks with schools for specific challenges:**
   This involves establishing collaborative networks within and among schools with teachers, students, families, heads of schools, and professionals for specific challenges. The aim is to foster sustainable practices, share knowledge, and develop new approaches to enhance open schooling initiatives and find better solutions for our persistent challenges.

2. **Link the national curricula to real-world problem solving to expand Open Schooling:**
   This emphasises the integration of national curricula with open schooling approaches and principles including practical and real-world problem-solving. It involves designing learning experiences that connect students with authentic challenges and encourage them to apply their knowledge and skills to address societal issues.

3. **Define shared visions collectively for solving local problems:**
   This highlights the importance of collaborative efforts in defining shared goals and visions for addressing local issues with collective design and implementation of strategies.

4. **Design personalised and accessible conceptual, methodological, and digital solutions involving all participants:**
   This emphasises the need to develop customised and inclusive information technology (IT) solutions and social tools (concepts, structures) that cater both to the diverse needs of participants in open schooling. It involves leveraging technology to create personalised learning experiences, ensure accessibility for all learners, and engage all stakeholders in the design and implementation of IT solutions.

5. **Promote transition to innovation governance:**
   This focuses on establishing effective governance frameworks and practices supported by technologies within open schooling contexts to integrate and analyse data from all schools and families. It involves ensuring responsible and ethical use of digital technologies, protecting privacy and data security, and promoting transparency and accountability.

6. **Seek national government support and funding from other stakeholders:**
   This highlights the importance of securing financial support and resources from various stakeholders, including science-based industries, local authorities, foundations, and other relevant organisations. The aim is to sustain and expand open schooling initiatives by securing funding for research, infrastructure, professional development, and program implementation.

7. **Provide autonomy through regulation for institutional change in schools to allocate working time for Open Schooling:**
   This emphasises the need for systemic and institutional change within schools to foster open schooling practices. It involves promoting innovative pedagogies, flexible learning environments, and supportive policies that enable schools to embrace open schooling principles and adapt their practices accordingly.

8. **Communicate the activities and challenges of Open Schooling to all stakeholders:**
   This stresses the importance of effective bidirectional communication to raise awareness and understanding of open schooling initiatives. It involves sharing information, guidelines, experiences, and challenges related to open schooling with various stakeholders. This involves know-how' tips on how to initiate and sustain the networks and communicate the open schooling activities, including the broader education community, policymakers, and the public about challenges addressed through OS with specific actions with and for youth and policy makers.

9. **Give recognition for all educators including teachers, students, scientists, and inspiring practices:** This highlights the importance of acknowledging and honouring the contributions and achievements of teachers, students, scientists, and other individuals involved in open schooling. It involves recognizing and celebrating inspiring practices, innovative approaches, and exemplary efforts that advance open schooling. Training is important to professionalise the open schooling network of people in and outside schools as agents of change.

10. **Empower teachers, students, families and communities with Open Schooling:** This emphasises the need to empower teachers, students, and families to actively engage in and benefit from open schooling practices. It involves providing professional development opportunities, promoting student agency and voice, and fostering strong partnerships between schools and families to support open schooling initiatives.

11. **Ensure that the process considers equity, diversity, and inclusive approaches for social justice.** This includes gender and socioeconomic differences / unprivileged and/or underserved communities. This underscores the importance of ensuring that open schooling processes and practices are accessible, inclusive, equitable, and responsive to diverse learner needs. It involves addressing systemic barriers, promoting equal access and opportunities, and adopting inclusive approaches that support social justice and educational equity.

12. **Ensure that the process follows a transdisciplinary approach considering different knowledge, practices and views:** This refers to integrating knowledge and perspectives from multiple disciplines to address complex issues, build new knowledge and create ideas. A transdisciplinary approach involves bringing together diverse fields, such as education, science, arts, and mathematics, to provide learners with a holistic and integrated learning experience.

13. **Ensure that the process helps learners identify a pathway for personal and career awareness with a diversity of aspirations:** This means providing students with opportunities to explore different career options and gain insights into the professional world, through meaningful interaction with experts (e.g., working together in common projects, having informal discussions). In open schooling, this involves connecting learning experiences to real-world careers, exposing students to various industries and working environments, and helping them understand the skills and knowledge required for different career paths.

14. **Ensure that the process promotes quality and innovation in STEAM education:** Quality in terms of high standards including effective learning objectives, outcomes, experience, and pedagogical support. Innovation is about research-based interventions that are responsive, recognised and valued by large number of educational communities. This highlights the importance of fostering creativity, problem-solving, and innovation within the domains of science, technology, engineering, arts, and mathematics (STEAM). In open schooling, promoting innovation in STEAM education involves creating learning environments that encourage hands-on projects, use of emerging technologies, and collaboration to develop critical thinking skills for the future.

Forty Actions

Recommendations	Examples of actions to implement the recommendations
1. **Create sustainable research and innovation networks around Open schooling**	**1. ADVOCATING:** Co-organize meetings with local, regional and national policy makers (e.g. science organisations, local authorities, Ministries of Education or Research) at various geographical levels (e.g. through Scientix's Science Thematic Seminars) to advocate for projects to address specific societal or local challenges through partnerships. **2. STAKEHOLDER ANALYSIS:** Perform stakeholder analysis in collaboration with schools and families for identifying key participants in each Open Schooling context, and ensure that their perspectives are considered. Stakeholders could include school leaders, teachers, students, parents, scientists, researchers, administrators, and representatives of local communities. **3. ROLE OF RESEARCH:** Engage researchers whose R&I priorities are related to the challenge or to relevant educational topics and facilitate their interaction with students and families. **4. COLLABORATE:** Organise meetings & workshops to promote collaborative evidence-based decision-making in Open Schooling contexts and create other opportunities for collaboration between schools. **5. POLICY MAKING:** Engage policy makers and other stakeholders during the whole Open Schooling process at early stage (e.g. with a webinar to get feedback and recommendations) to design/promote evidence-based policies. **6. MUTUAL LEARNING:** Engage teachers and scientists in mutual learning processes within communities of practice.

Recommendations	Examples of actions to implement the recommendations
2. **Link Open Schooling to real-world problem solving**	**7. NEEDS ASSESSMENT:** Engage stakeholders in needs assessments to identify: • Specific needs and capacities of schools to implement Open Schooling • How much support is needed for schools to implement Open Schooling • Which local problems are more relevant to respective countries, areas, and schools, with a special focus on those that affect disadvantaged students, vulnerable and under-represented actors. • Specific needs of researchers and policy makers such as funding providers, government agencies, and school administrators. **8. PRIORITY SETTING:** Define the priority problems to address, in collaboration with schools, families, administrators and researchers.
3. **Collectively define shared visions for the solution of local problems**	**9. SHARED VISION:** Engage all stakeholders to define a shared vision for the resolution of the problem, considering new trends, new perspectives, and evidence-based criteria.
4. **Design personalised and accessible IT solutions involving all participants**	**10. DIGITALIZATION:** Promote more intensive and inclusive use of ICT to open up schools to science & industry and to the wider community including also Special Educational Needs and Disabilities (SEND). Co-design and co-create solutions and digital outputs, based on evidence obtained from Open Schooling, that are accessible to all and based on participants' needs and motivation.

Recommendations	Examples of actions to implement the recommendations
5. **Promote digital governance**	11. **DIGITAL COLLABORATION involving professionals, protocols AND COMMUNICATION TOOLS** to facilitate governance of Open Schooling and problem-solving activities. 12. **COLLECTION, INTEGRATION AND ANALYSIS OF DATA** on the situation of young people and their communities at local, regional and international levels. 13. **PROMOTING THE INVOLVEMENT** of young people and families in open governance processes. 14. **EMPOWERING YOUNG PEOPLE AND FAMILIES** to take control of data collection and analysis and use the results in governance processes.
6. **Seek funding from science-based industries, local authorities and other stakeholders**	15. **FUNDRAISING:** Support schools and stakeholders to increase their human and economic resources in relation to fundraising (involving governments). 16. **DIFFERENT SORTS OF FUNDING:** Identify (e.g. national funding for mobility, funding from programmes that facilitate access to education resources at local, national and international levels.
7. **Promote institutional change in schools**	17. **INSTITUTIONAL CHANGE:** schools need the necessary autonomy to Integrate Open Schooling into existing education institutions and systems. 18. **TIME FOR OPEN SCHOOLING:** Allocate protected time (weekly or monthly) for teachers to design, implement and participate in Open Schooling projects, in collaboration with other teachers and stakeholders.

Recommendations	Examples of actions to implement the recommendations
8. **Communicate the activities and challenges of Open Schooling**	**19. ALLIANCES:** Identify other EU projects focused on citizen science and participatory science to establish alliances for knowledge exchange and impact (e.g. *Open Schooling Together*).
	20. IMPACTFUL INITIATIVES: Publish articles about Open Schooling in high impact social media and in print.
	21. CO-ORGANIZATION OF EVENTS: Co-design and Implement events such as workshops, webinars or festivals (e.g. with Scientix, European Parents Association, Children's Universities) taking advantage of World Days and other external events.
	22. EDUCATION REPOSITORIES: Publish Open Schooling resources in education repositories and ask teachers and organisations to recommend them.
	23. POLICY REPORTS: Write policy reports on CONNECT findings and benefits and circulate them in order to engage policy makers.
	24. LEAFLETS: Prepare a very clear one page leaflet per target audience on what we are offering, what the benefits are for them and how they can use CONNECT resources.
	25. SCIENTIFIC PUBLICATIONS: Publish articles about Open Schooling and its practices in scientific journals.
	26. COMMUNITY AS COMMUNICATORS: Communities, including youth, can report problems tackled and benefits gained.
	27. STUDENTS AS SCIENCE COMMUNICATORS: Increase local initiatives for students to present their scientific projects and ideas.
	28. DISSEMINATION OF THE SHARED VISION: Spread the vision as widely as possible.

Recommendations	Examples of actions to implement the recommendations
9. **Give recognition for teachers, students, scientists and inspiring practices**	**29. AWARDS:** Give awards & certificates (e.g. recognition at national level with the CONNECT Open Schooling open badges) for teachers and students **30. PERSUADING ORGANISATIONS:** Recognise scientists and researchers participating in OS (e.g. in their communication campaigns with scientific organisations) **31. INSPIRING PRACTICES:** Disseminate inspiring practices and Open Schooling resources through websites and other channels provided by CONNECT and its participating communities. **32. BENEFITS:** Disseminate benefits of inspiring practices with a focus on multi stakeholder networks and collaborations.
10. **Empower teachers, students and families for Open Schooling**	**33. EMPOWERMENT:** Empower participants to think critically, to engage in real problem solving, to learn transdisciplinary and ICT skills and to co-create Open Schooling resources with: **a.** Training (e.g. Open Science summer schools, training in schools by scientists, for students) **b.** Providing resources & guidelines for training **c.** Offering Mentoring Schemes for students and families **d.** Engaging researchers, especially PhD candidates, interested in equity, diversity and inclusion
11. **Ensure that the process considers equity, diversity and inclusive approaches for social justice**	**34. DIGITAL INEQUALITIES:** Provide equipment and Internet connection to schools and students at home, if these are lacking; ensure protection to other children's rights. **35. GENDER EQUALITY:** Support gender equality in local situations, bearing in mind that boys, girls and other groups may be disadvantaged in different ways. **36. LEARNING INEQUALITIES:** Consider that learners do not all learn at the same speed or in the same way. **37. SOCIAL INEQUALITIES:** Identify Socio-economic disadvantage hinders learning, career progression and social mobility.

Recommendations	Examples of actions to implement the recommendations
12. **Ensure that the process follows a transdisciplinary approach**	**38. TRANSDISCIPLINARY SKILLS:** Ensure that Open Schooling resources facilitate the learning of transdisciplinary skills, e.g. combining sciences with arts and humanities subjects.
13. **Ensure that the process promotes career awareness**	**39. CAREER AWARENESS:** Ensure that Open Schooling promotes awareness of the world of work, the need for generic skills and the widest possible range of opportunities, within and beyond STEAM based careers.
14. **Ensure that the process promotes innovation in STEAM education**	**40. STEAM EDUCATION:** Promote innovation in STEAM education by identifying good practices that enable young people to increase their confidence, enjoyment, and wellbeing. Use phenomenon-based learning to build deeper understandings of the world and to increase young people's ownership of learning.

Participate in this Declaration
to transform Education by ensuring Open Schooling for all
Access this QR code, SIGN IN and SHARE it within your networks.

OSD
Open Schooling Declaration

Open Schooling Declaration and AGENDA2030: The Power of Acceleration

Open Schooling Declaration and AGENDA2030: The Power of Acceleration

Halfway through the UN's 2030 Agenda, it is evident that our progress toward the Sustainable Development Goals (SDGs) is significantly off track. Projections paint a challenging picture, suggesting that the world may not achieve these ambitious goals by 2030. However, in these times of crisis and change, a strategic approach emerges: SDG Acceleration Actions (UNESCO, 2023). In our rapidly evolving world, characterised by crises and transformations, a compelling call to action emerges. The SDGs, a shared global vision, require universal science and technology-based strategies and mechanisms tailored to address common barriers and propel us toward a more inclusive, equitable and peaceful world.

SDG Acceleration Actions are voluntary initiatives undertaken by governments and non-state actors, independently or collaboratively, to accelerate the implementation of the SDGs. These actions not only build on existing efforts, but also address the educational nature including interlinked open schooling of the 2030 Agenda, catalysing progress. These actions are key to catalysing transformations toward sustainable development. They have a focus on science-based solutions and the imperative to address global challenges supported by political leaders, international organisations, the private sector, civil society, women and youth, and other stakeholders.

The SDG 2023 summit at the United Nations New York focused on the discussion of the Acceleration Actions to support nations with knowledge exchange about strategies for the next seven years. Projections indicate a challenging picture, suggesting that the world has a very arduous road ahead. The discussion highlighted the issues, investments and incentives to accelerate progress toward achieving the Sustainable Development Goals (SDGs) by 2030. This event built on twelve high-impact initiatives that the UN had been working on prior to the SDG Summit, focusing on key areas such as SDG transitions.

Attendees included heads of state, ministers, UN leaders, representatives of the private sector, civil society, and more. The event featured high-level opening and closing segments, sessions dedicated to high-impact initiatives, discussions on the Digital SDGs, crisis situations, and gender equality. The expected outcomes were to showcase examples of countries that have made significant progress and to unite governments and stakeholders in committing to actions aligned with national priorities. Six mobilisation groups were actively involved in the discussion of the acceleration: civil society, youth, local and regional government, the women's movement, the private sector, and small and medium-sized enterprises, along with large groups and other stakeholders.

In this event, Dr Alexandra Okada from the Open University represented the CONNECT project and the Open Schooling Together network. She introduced the Open Schooling Declaration (OSD) as a strategy to accelerate the promotion of quality education. The Open Schooling movement also emerged in 2015 in the report "Science Education for responsible citizenship" launched in the same year of 'The Sustainable Development Goals'. The Open Schooling approach involves integrating real-world SDG-related issues into primary, secondary and tertiary education that local communities care about (CARE), want to know more about (KNOW), and can take action to contribute solutions (DO). The CARE-KNOW-DO model was presented, including the OSD and the CONNECT-Science instrument for young people's self-assessment of self-efficacy and self-concept of science and technology in their lives.

The OSD has the potential to help governments and non state actors educate the current generation by aligning knowledge, skills, attitudes, and values with real-world challenges for the 2030 Agenda. The OSD can serve as a valuable tool to reinforce the five key strategies of the SDG acceleration plan. These strategies include:

1. Encourage public engagement through socioscientific thinking for broader and more meaningful community representation. It is essential to create national plans that actively involve the public. This means fostering partnership between local governments, businesses, industries, institutional investors, educational providers, and the wider community in the planning process.

2. Strengthen the capacity of economic levers that improve decision-making with the cooperation of different actors. National and international economic and financial instruments should be leveraged. This includes providing incentives for research

and innovation, making changes, and improving responsible research and innovation processes for action involving problem-solving and decision-making.

3. Development of data and science-based tools through collaborations between universities, schools, local communities, businesses, and policy authorities. To accelerate progress, investments in science-based data, resources and tools, education and policy learning are needed. These tools provide the foundation for making informed decisions.

4. Foster new partnerships that bridge the domains of science, policy, education, and society to empower students with real-world problem-solving skills. Establishing partnerships that improve the interface between science, policy, education, and society is crucial. These partnerships increase the utilisation of scientific evidence and build trust in both science and information and public participation.

5. Ensure accountability by monitoring progress, providing input and feedback to stakeholders, and identifying appropriate incentives for transformative change. Management and commitment mechanisms at the international, national, and local levels are crucial to track the progress, commitment, and cooperation of stakeholders.

In the acceleration plan involving five crucial strategies, open schooling can play a catalytic role in improving the SDG4 - quality of education articulated with all sixteen SDGs. Figure 1 summarises the strategies and five key components of Open Schooling to support leaders in seeking catalysts in education.

SDG SUMMIT 2023

SDG Next Steps	**1. Develop National Plans of action to accelerate SDGs**	**2. Encourage business and organisations to share learning**	**3. Employ Economic & Financial Levers (inter & national)**
OS DECLARATION	(OSD-07) Open Schooling connects students with science for wellbeing and sustainability, **transforming education.** (OSD-03) **Real-world applications** of science foster students' meaningful learning towards a deep understanding rather than superficial knowledge.	(OSD-01) Open Schooling brings together schools, **business professionals,** university researchers, and civil society for **authentic education.** (OSD-02) Students discuss real-life problems and solutions with **professionals and communities** through **participatory methods.**	(OSD-11) **Learning communities** care about real-world issues, know their needs, and take action. (OSD-05) **Responsible Research and Innovation** increase awareness of **future-oriented careers** to empower students as sustainability agents.
OS ACTIONS	1. Develop an international OS-SDG showcase with effective OS partnerships. 2. Support knowledge exchange and capacity building for scalability.	3. Establish partnerships with enterprises that align with SDGs. 4. Recognise issues and skills demonstrated by professionals in support of the SDGs.	5. Identify sustainable incentives for partnerships. 6. Explore new grants to support and expand existing OS networks.

4. Invest in Data and Science-Based Tools and policy learning

(OSD-08) Studentsdevelop **competences in authentic contexts** using socioscientific thinking andinterdisciplinary knowledge.

(OSD-06) Students co-create **knowledge** and practice **skills** relevant to them with **science, arts, and humanities** curricula.

7. Create a repository with evidence-based data, tools research and policy.

8. Increase Open Schooling awareness with science-tools and digital social media.

5. Strengthen science-policy-society interface

(OSD-04) **Families, experts, resources, and technologies** help with personalised learning by considering students' individual learning needs.

(OSD-10) Open schooling partnerships are key for **open democracy** and **social justice** locally and globally.

9. Expand number of OS research with PhD students from different fields.

10. Embed knowledge about Open Schooling in teacher education courses.

6. Improve Accountability of stakeholders

(OSD-09) Open Schooling promotes curiosity, ownership, and citizenship, enabling students to **act responsibly with responsive actions.**

(OSD-12) Open schooling helps students develop sense of belonging, enjoyment, and **confidence in science for life.**

11. Update curriculum plans with OS+SDGs evidence-based tools and recommendations.

12. Connect underserved learners and less-represented communities with Open Schooling initiatives.

CONNECT
Students & scientists solving real-problems

Open Schooling together

Figure 1: Open Schooling Declaration and AGENDA2030: The Power of Acceleration.

Open Schooling Declaration in the context of the UN SDG Acceleration Action

Science is at the heart of tackling global challenges and advancing the SDGs. From eradicating poverty to tackling climate change and biodiversity loss, science provides the foundation for transformative change. It thrives when multidisciplinary, ethical, inclusive, trustworthy, open, and socially robust education.

Open Schooling is a crucial component in advancing SDG Acceleration Actions, serving as a science-based tool to address common obstacles and foster a more inclusive, equitable, and peaceful world. It achieves this by optimising a meaningful learning continuum accessible to all, connecting a diverse range of learning environments, including homes, museums, libraries, parks, centres, and digital media. This educational approach uses authentic science-based education and multidisciplinary approaches involving partnerships between schools, universities, businesses, civil society, and policymakers. Its goal is to empower all students, including young people from underserved communities, to use scientific thinking with real-life issues that can contribute to the advancement of the SDGs.

Open Schooling is characterised as inclusive, reliable, and socially robust, implying that it is a means of providing accessible and quality education to a broad and diverse population.

Open Schooling is instrumental in empowering the next generation, especially young people facing challenges resulting from the pandemic, underserved learners, and vulnerable communities affected by climate change, sustainability issues, global economic crises, and rising unemployment. It is also designed to address the difficulties in supporting student retention and progression. This holistic pedagogy provides students not only with academic knowledge but also practical skills, attitudes, and values essential for fostering a socially resilient society, human well-being, and the transition to a digital and green economy. It acknowledges that education should extend beyond the confines of the classroom to encompass various facets of life, nurturing well-rounded individuals who are prepared to tackle real-life issues of the 21st century.

Understanding what and how transformations can be implemented is key, and here the concept of SDG Accelerations Actions comes to the fore. Deliberate and desirable transformations, vital to achieving the SDGs, are possible. Education plays a key role in prioritising this search for sustainable development. In this context, Open Schooling is designed to empower students to become decision-makers by engaging in discussions, engaging their communities and experts, and adopting transdisciplinary approaches. It equips them to make informed decisions, take impactful actions, and provide recommendations. As we face times of crisis and change, SDG Acceleration Actions and science-based solutions provide hope for a better future. By embracing these initiatives, nurturing tomorrow's leaders and fostering collaboration through open education, open universities and open schools, we can work together to achieve the SDGs.

The UN 2030 Summit serves as a platform for dialogue and action, uniting stakeholders from around the world in the pursuit of sustainable development. We can create a better world and a better future by doubling our efforts to achieve the Sustainable Development Goals by making the transformative changes enshrined in the 2030 Agenda. Through these actions, we can withstand global shocks, build resilience, and emerge stronger with Open Schooling ready to meet the challenges that lie ahead.

Dr. Alexandra Okada – UN Advisor, DG Summit 2023 United Nations New York, 18-19 September 2023.

Timeline

1992

Earth Summit
UNCED
United Nations Conference on Environment and Development in Rio de Janeiro

UNFCCC
United Nations Framework Convention on Climate Change

1997

Kyoto Protocol

Carbon Reduction Agreement

2011

UNEP

Sustainability without poverty

2015

SUSTAINABLE DEVELOPMENT GOALS

① UN SDG Summit 2015

② OS Open Schooling

③ Paris Agreement
2015-2030:
50% less
2030-2050:
netzero

2023

UN SDG Summit 2023

OS Declaration

2024

UN Summit of the future

OS Future

2025

UN COP30 Amazon Brazil

2030

UN SDG Agenda 2030

References with useful links and a summary

Four references related to the SDG2023 summit provide highlights on key points discussed during the SDG2023 week:.

1. ***Political Declaration adopted at the High-level Political Forum on Sustainable Development (HLPF) under the auspices of the General Assembly in September 2023***
   The document highlights the challenges and crises facing sustainable development, the need for international cooperation, and the importance of equity, inclusion, and environmental conservation. It also reaffirms the critical role of children and youth in achieving the objectives of the 2030 Agenda.

2. ***The 2023 Global Sustainable Development Report (GSDR) titled "Times of Crisis, Times of Change: Science for Accelerating Transformations to Sustainable Development"***
   This report underscores that incremental and fragmented changes will not suffice to achieve the Sustainable Development Goals (SDGs) by 2030. Urgent, science-based transformations are essential, necessitating global cooperation and leaving no one behind.

3. **Report "Progress toward the Sustainable Development Goals: toward a Rescue Plan for People and Planet"**
   This report, addressing progress toward the Sustainable Development Goals, is a response to the General Assembly resolution titled "Transforming our world: the 2030 Agenda for Sustainable Development." Marking the midway point to 2030, this special edition update reviews developments against the global Sustainable Development Goal indicator framework since 2015. The Secretary-General identifies that numerous Goals are significantly behind schedule and proposes five crucial recommendations to reinvigorate the Goals and expedite their realisation by 2030. Member States were invited to consider these recommendations in preparation for the Sustainable Development Goals Summit.

4. United Nations Secretary-General's SDG Stimulus to Deliver Agenda 2030 – February – 2023

This document highlights how various crises, including the COVID-19 pandemic, the war in Ukraine, high inflation, and climate change, are affecting economies worldwide. The report points to the need for systemic changes in international finance and monetary systems to address these issues and accelerate progress toward the SDGs. It proposes the SDG Stimulus, which aims to mobilise at least $500 billion annually for sustainable development, primarily through a combination of concessional and non-concessional financing. The document emphasises the importance of implementing necessary reforms at both international and national levels to achieve these goals.

Final Remarks

In conclusion, this book serves as a valuable resource for educators, parents, and stakeholders invested in empowering students to embrace science and its applications in their lives and future careers. By presenting principles, practices, and tools, it equips readers with the necessary means to enhance students' confidence and aspirations in utilising science.

The evidence from the CONNECT project, involving a wide range of participants, highlights the transformative potential of open schooling. The project's findings demonstrate that open schooling can create inclusive, engaging environments that foster well-being and sustainability in schools. It emphasizes the importance of integrating science-action into the core curriculum, engaging families, universities, and enterprises to collaborate on real-life problem-solving.

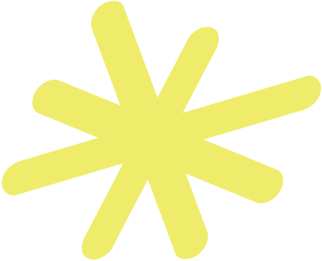
As we reflect on the insights gained from the book, several important questions emerge. How can we ensure the successful adoption of open schooling in primary and secondary schools? What strategies can be implemented to effectively incorporate socio-scientific issues that students care about into the curriculum? How can we further engage families, universities, and enterprises to actively participate in school-life activities and contribute to students' aspirations and science capital?

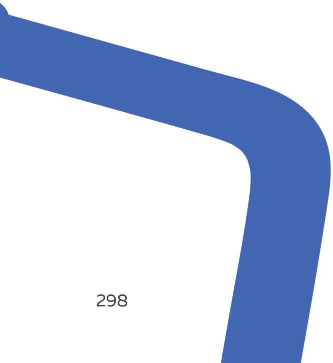
To move forward, it is crucial to embrace the CARE-KNOW-DO framework presented in this book. By creating a flexible and engaging environment, we can empower students to explore the world through socio-scientific issues they care about, equip them with the science knowledge they need to know, and encourage them to take science-based actions that benefit their lives, communities, and society.

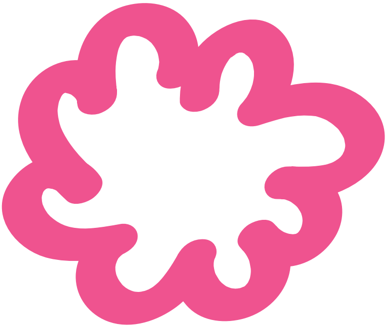
Moreover, a continued focus on participatory science is essential. By involving families, universities, and enterprises, we can enrich students' experiences, increase their aspirations, and foster affective engagement with science. This collaborative approach ensures that students are connected to the broader scientific community, amplifying their sense of purpose and motivation.

In the next steps of this journey, it is crucial to disseminate the knowledge and practices shared in this book widely. Training programs, workshops, and collaborations with educational institutions can help implement open schooling principles and practices across various schools and regions. Continual research and evaluation are necessary to refine and improve these approaches, ensuring their effectiveness and adaptability to different contexts.

Ultimately, by prioritizing open schooling, integrating science-action, and fostering participatory science, we can inspire future generations to embrace science, make meaningful contributions, and shape a brighter, more sustainable future for all.







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Appendix – Open Schooling Resources

This section provides an overview about structured curriculum materials. Each curriculum material contains activities for students and guidelines for teachers. Scientists and families play a key role during the CARE and DO phases; while teachers support the KNOW process. A total of 100 best practices are available on the CONNECT website to illustrate how teachers are implementing the CARE KNOW DO framework and how they used the material. They were evaluated using instruments of WP6 to assess the students' competences achieved (knowledge, skills, and attitudes).

Name	Length	Summary	Science topic
Microplastics	Long	Students learn about the size and scale of small particles. They act as teenage activists to convince people how they can best reduce their contribution to microplastic pollution and why they should.	Particle model Mixtures
Energy savers	Short	Students create a crowd-funding campaign to help an entrepreneur fund the development of a new energy saving device.	Energy transfer Wasted energy
Rewilding	Long	Students create a campaign to convince the public that an extinct animal should be rewilded.	Food webs Competition Abiotic & biotic
Poo transplants	Short	Students advise a family friend about whether a faecal transplant can help cure obesity.	Digestion
Carbon Neutral	Short	Students help a café to become carbon neutral by reducing carbon emissions and offsetting.	Climate change
Handwashing	Long	Students take part in experimental work to visualize microorganisms and to raise awareness that contagion can be prevented through handwashing.	Infectious disease
Transmission	Long	Students carry out an experiment that simulates contagion in a community and how mask wearing affects transmission. They design and develop an activity aimed at communicating the importance of masks to reduce infection.	Infectious disease
Ventilation	Long	Students apply the knowledge acquired about methods of transmission and develop a final product that responds to the problem by proposing recommendations for improving the current school ventilation protocol.	Infectious disease
Aerosols	Long	Students evaluate the feasibility of using carbon dioxide sensors to monitor the risk of covid transmission inside buildings.	Infectious disease
Creating and Using Maps for Problem Solving	Long	Students use mapping skills to solve a spatial problem that they face in their daily life.	Geography in daily life
Biodegradable plastics	Long	Plan and carry out a campaign to convince the public and the authorities that the conditions/framework should be provided for the gradual introduction of products based on biodegradable plastics.	Earth's resources

Table 10: Open Schooling Resources. Long 8 – 12 lessons, short 3 – 6 lessons.

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CONNECT

Students & scientists solving real-problems

The book introduces principles, practices, and tools to boost students' confidence and aspirations in using science in their lives and careers. Evidence from the CONNECT project, involving over 1,000 teachers, 16,000 students, families, and scientists, emphasizes the importance of open schooling for creating inclusive, engaging environments that prioritize well-being and sustainability. CONNECT supports primary and secondary schools in adopting open schooling by integrating science-action into their core curriculum. This includes participatory science with various stakeholders such as families, communities, universities, and enterprises, working together to solve real-life problems.

Key points:

1. The CARE-KNOW-DO framework enables schools to establish a flexible and engaging environment where students explore socio-scientific issues they care about, learn essential science curriculum, and take science-based actions.

2. SCIENCE-ACTIONS encourage students to apply their science knowledge, skills, and attitudes for the benefit of their lives, community, and society.

3. PARTICIPATORY SCIENCE involves families, universities, and enterprises in school activities, contributing to increased student aspirations, science capital, and affective engagement with science.

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