CONNECT International Conference on Open Schooling

#CICOS2023

6 – 7 July, 2023 | Barcelona, Spain

PROCEEDINGS

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PREFACE

Welcome to the proceedings of the 1st CONNECT International Conference on Open Schooling (CICOS 2023), a scientific conference organized by the consortium of the CONNECT project, funded under the EU's research and innovation funding program, Horizon 2020. CICOS 2023, which took place at the Museo de la Ciencia CosmoCaixa in Barcelona, Spain, from July 6th to 7th, 2023.

CICOS 2023 served as a platform for the open schooling (OS) community to come together with the goal of sharing and reflecting on OS practices, addressing challenges, exploring opportunities, and supporting the achievement of sustainable development goals through open schooling. The conference also aimed to disseminate the results from the CONNECT project and other Open Schooling projects.

For many educational institutions, including universities, schools, and other providers, open schooling is a relatively new practice that has gained increasing prominence within Europe and beyond. Open schooling offers meaningful pedagogical strategies, tools, services, and digital platforms to create learning opportunities for diverse partnerships involving students, teachers, academics, scientists, family members, and community stakeholders, all working together to discuss and implement solutions for real-life problems.

Open schooling is a transformative approach to education that harnesses partnerships, technology, and open educational resources, enabling learners to identify real-world problems and engage in discussions with their communities and science professionals. Students are encouraged to address real issues that they CARE about, which creates the need to KNOW, and DO actions to make a positive impact on the world while developing valuable skills. Open schooling fosters quality education, equipping students with the skills needed for sustainable careers and the transition to digital and green innovation. This approach has the potential to break down barriers in education by expanding students' knowledge, skills, attitudes, and values required for success in the 21st century.

During the period from 2020 to 2023, which was significantly affected by the pandemic, numerous European-funded projects joined forces to establish various Open Schooling Networks. We were delighted to welcome nine project leaders coordinating action projects focused on open schooling at CICOS2023. We are currently in a transition to an innovation period, with educational institutions adapting to the "new normal" and concentrating on meeting the needs of learners and educators in a post-pandemic world. In the face of adversity, open schooling has proven to be a powerful approach that transforms schools into hubs of well-being within local communities.

CICOS2023 welcomed a diverse range of participants, including:

- Researchers and policymakers focused on research and innovation in education and the challenges addressed through open schooling.
- School leaders interested in positioning their schools as agents of change within their communities through open schooling.
- Non-formal educators from science museums, leisure, and social services seeking to increase their impact.
- Teachers and students engaged in or interested in open schooling practices.
- Support services, project managers, and publishers involved in the development, dissemination, and implementation of open schooling educational resources.

To further advance the open schooling movement, CICOS 2023 launched the Open Schooling Declaration, which was also disseminated at the United Nations in New York during the SDGs 2023 summit in September 2023. The Open Schooling Declaration represents a significant strategy aimed at accelerating the quality of education in the short term, addressing learning loss, promoting equity and diversity, and making a coordinated effort to reinvent education as more human-centred and responsive

to the evolving needs of educators, learners, research and innovation centres, and local communities in an ever-changing world.
The CICOS2023 sessions encompassed keynote presentations, parallel sessions, workshops, open discussions, and poster presentations.
The CONNECT International Conference spanned a wide range of topics within the realm of open schooling in STEAM education, including:

1. Inclusion, Democracy, and Equity supported through open schooling.
2. Participatory Methodologies for collaborative work with researchers and other stakeholders.
3. Open schooling supporting the arts and socio-cultural awareness.
4. Ecosystem stability using open schooling methodologies.
5. Open schooling for society's health, nutrition, and well-being.
6. Affordable and clean energy, materials science, and technology for sustainable development.
7. Open schooling for science careers in emerging labour markets.
8. Open schooling for climate change and environmental green digital transition.
9. Open schooling practices that engage students with CARE-KNOW-DO.

CICOS 2023 provided a significant platform for discussions on open schooling practices that are reshaping education towards sustainability. The conference received 75 research abstracts, with 45 presentations of papers and posters. Out of these, 20 papers have been selected for inclusion in these proceedings. All submissions underwent a rigorous double-blind review process, with each paper being evaluated by at least two members of the CICOS committee. The review process was followed by discussions and a final review supported by the program and scientific chairs, resulting in an 80% acceptance rate, with 16 papers included in this proceedings volume.
The conference also featured four workshops, a doctoral meeting, and consortium pre-conference activities held on July 4–5, 2023.
We would like to express our heartfelt gratitude to all the colleagues involved in organizing, writing, and reviewing the contributions to this year's conference. Special thanks go to all the members of the Program Committee who conducted reviews on the submitted contributions, engaged in discussions, and facilitated the decision-making process regarding their acceptance. We extend our sincere appreciation to the keynote speakers, Lars Kluver (DBT), Eszter Salamon (IPA, ESHA), Carley Sefton (LTL-UK), Giuseppe Mossutti (EUN), and the expert panelists, Peter Gray and Gultekin Cakmakci, for their invaluable contributions to the conference program. Lastly, we want to thank all the in-person and online attendees who participated in this conference.
Sincerely,

Alexandra Okada (scientific Coordinator Chair)
Georgios Kolinis (Programme Chair)
Alexandros Koukovinis (Communication Chair)

Scientific Committee Chair

Dr Alexandra Okada

Program Committee Chair

Dr Georgios Kolionis

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Mihai Bizoi, Romania

Giorgos Panselinas, Greece

Silvar Ribeiro, Brazil Northeast

Patricia Torres, Brazil South

Tony Sherborne, United Kingdom

Doctoral Consortium Chairs

Raquel Kowalski, Brazil South

Poster/Demo Chair

Ana Beatriz Rocha

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CONNECT website
https://www.connect-science.net/

Open Schooling: Overcoming barriers from policy to practice.

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Abstract. The UK's CONNECT project aimed to create high-quality teaching resources aligned with school curriculum objectives, promoting Open Schooling in mainstream education. While these resources found favor among teachers, persuading school leaders to embrace this approach presented challenges, given the relatively limited awareness of Open Schooling outside of academic circles. Our research, involving 172 teachers, employed a blend of qualitative and quantitative methods, including interviews, observations, and online surveys. The results reveal increased socio-scientific and emotional engagement among 972 out of 4,300 students, with 82% of students acknowledging the importance of science and math for problem-solving, underscoring the practical value of science education. Our findings lead to recommendations for a new qualification plan for 14–16-year-olds in the UK and underscore the need for increased research grant opportunities to extend the Open Schooling movement within and beyond Europe by 2030.

1. Introduction

The focus of CONNECT project in the UK has been on developing high quality teaching resources aligned to curriculum goals at a school level. The aim of this is to help operationalise Open Schooling in mainstream schools. However, despite these resources being very popular (4,038 downloads considering various channels and platforms) and enthusiastic feedback from the network of teachers we have built, it has been hard to convince school leaders to take a risk on what they see as a luxury in the curriculum.

In the UK open schooling as a pedagogy is not well understood outside of academic circles and small pockets of enthusiasts in individual schools or organisations such as the Green Forum whose aim is to support the UK Government in the DfE Sustainability education action plan [1]. Despite our efforts, the benefits of Open Schooling to wider society are not well understood in the UK - there seems little recognition of the added benefits to the child and to society of empowering our students by helping them connect science to their lives.

2. Transformative effects of Open Schooling

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 (figure 1). 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 [2]. 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 [3] for problem solving in real-life.

Our aims were to show UK schools the transformative effects of Open Schooling on both teaching approaches and students' engagement, understanding including science capital and affective engagement [3] in order to encourage schools to adopt Open Schooling strategies going forwards. Our materials unify diverse perspectives by considering learning as a progression from surface learning to deep learning and ultimately to the application of knowledge [4]. In our model, the "KNOW" phase corresponds to surface learning, but certain CONNECT Science activities are designed to deepen this learning. On the other hand, the "DO" phase focuses on transferring knowledge and skills to new contexts. The social context introduced in the "CARE" component is also a crucial factor in facilitating students' ability to apply knowledge from the classroom to real-world situations. Therefore, CONNECT encourages interaction with families to link science to real-life concerns and with scientists to provide authentic examples of scientific thinking, thereby building students' confidence in applying science in their daily lives. The three components of the CARE-KNOW-DO framework mutually support each other to enhance students' engagement with science, making them equally indispensable for long-term sustainability.

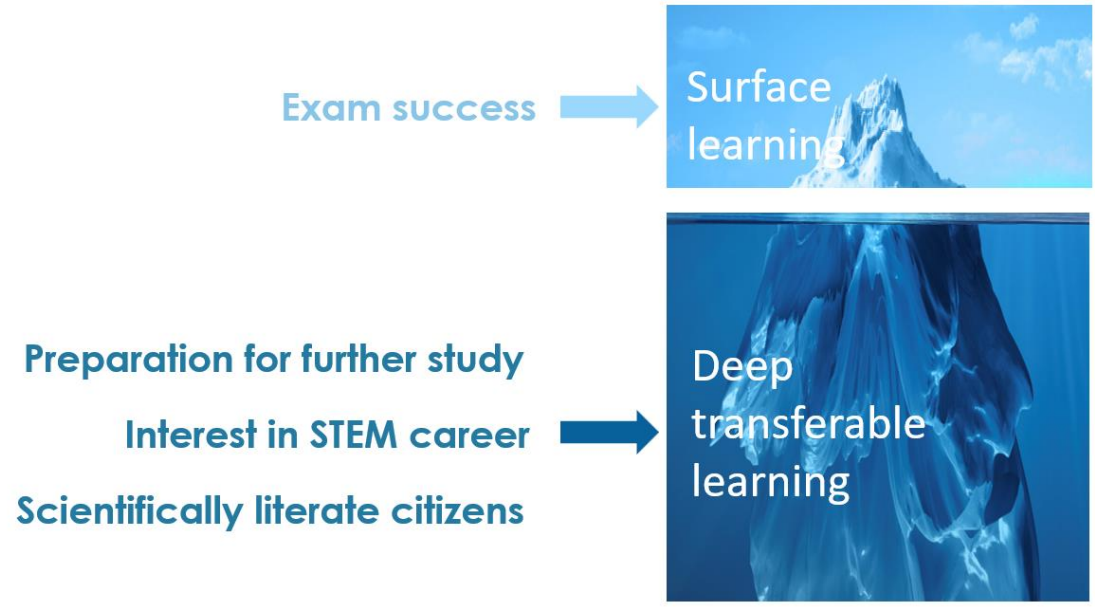

Figure 1: Open Schooling helps students to obtain deep transferable learning (Sherborne, 2023)

3. Methodology

In order to break down some of the barriers to adopting Open Schooling we designed a number of high-quality open schooling resources underpinned by the CARE-KNOW-DO framework for students to develop science-actions (table 1). These materials are simple to implement, are based on engaging socio-scientific topics, have strong links to the UK science curriculum and vary in length, making them suitable to be used in a wide variety of classrooms. The science-actions were free to download both from the CONNECT and Mastery Science website and were advertised by means of newsletters and social media posts.

Table 1: Science actions created for the CONNECT project

Name	**Curriculum area**	**Science actions for students do towards real-life socio-scientific issues' solutions**
Rewilding	Food webs, competition	Persuade the public that an extinct animal should be rewilded back into UK forests.
Energy savers	Energy transfer, energy efficiency	Create a funding campaign for a new energy saving home device.
Carbon neutral	Climate change	Act as carbon consultants to help a café become carbon neutral.
Poo transplants	Digestion	Help a friend decide whether to have a faecal transplant.
Microplastics	Particle model, mixtures	Design an invention to stop microplastic pollution of the oceans.

Qualitative methods such as interviews and observations provided in-depth perspectives, while quantitative methods, using online surveys for both teachers and students were supported by the CONNECT-science instrument. These measured how many open-schooling strategies teachers used and their confidence. In students we looked at and measured science capital and affective engagement [5].

4. Transformation in UK teachers

A total of 172 teachers completed the survey. They taught students from year 5 (10-11 years old) to year 13 (17 -18) and the majority were female (70%). The experience was positive with 98% of teachers saying they would like to participate in new activities similar to the science-action.

After using a CONNECT science-action, teachers were asked to state which strategies they used normally in their classrooms. Those that were used the most often included:

- Teacher explaining ideas (82% very often or always)
- Teacher demonstrations (61%)
- Students participating in whole class discussion (63%)

These results are evidence that teachers are using didactic teaching methods, an approach that Open Schooling aims to move away from. However, the data does not show what proportion of a lesson is taking up using these approaches so they could feature lightly. Whole class discussions were a popular activity, however small group discussion featured much less frequently (48%). This could reflect a lack of activities where small group discussion is useful, or a lack of confidence in running them, either because of a lack of student or teacher skills.

Strategies that were used the least often were:

- Students using collaborative games/role play (12%)
- Students using textbooks (16%)
- Students developing collaborative inquiry projects (18%)
- Students raising issues for discussion about the topic (29%)

A lack of textbook use in UK schools could be because of a move towards students using other sources of information such as digital resources, budgetary constraints or students not being able to access them. As one teacher explained in a comment*: "support for literacy and numeracy is vitally important as well as digital competency".* Using collaborative approaches is a feature of Open Schooling that UK teachers use the least. This is most likely because of a lack of training into how to use them. One comment from a teacher supports this hypothesis *"project work is an issue - I don't know how to do it but am expected to"*. A lack of time in the curriculum is also a likely explanation.

Teachers were also asked to rate how confident they were with Open Schooling activities. They rated the highest confidence in:

- Teaching scientific enquiry with real life problems (71% confident for the most parts or very confident)
- Promoting science learning activities beyond the school curriculum (67%)
- Promoting discussion about science in society in the classroom (62%)
- Helping students to air their views and listen carefully to others in group discussions (62%)

These were aspects that featured most prominently in the science-actions, which showed that the resources helped teachers to develop these aspects of Open Schooling. This is encouraging, and the hope is that teachers will continue to use these.

Lowest levels of confidence were seen in:

- Using questions to trigger divergent modes of thinking and argumentation (34%)
- Encouraging students to discuss science topics with family members (40%)
- Discussing with students the learning goals that include scientists (41%)
- Help students generate questions with evidence-based views (52%)

These point to areas that could be developed in future projects.

Around half of teachers (45%) reported that families participated in the activities, with varying success. One teacher commented that *"families discussed the various options for rewilding. This was a successful homework"*, while another reported that 'some parents did not want to/appropriately take part but a lot did'. The success of family involvement relies on good school/parent relationships and historical experience of parental involvement in home activities, which varies from school to school.

The majority of schools (59%) did have scientists participating in the activities, using either videos, online meetings or in person. The scientists carried out a variety of roles including discussing technologies and judging student presentations. One teacher *commented "we felt a lot more confident in having experts work with us"*.

5. Transformation in UK students

Approximately 4,300 underserved students engaged in a science-driven initiative under the guidance of 172 teachers. On average, each teacher had a classroom with 25 students, consistent with the typical classroom size in the UK. Out of this entire cohort, 910 students (equivalent to 21%) voluntarily participated in the CONNECT-SCIENCE questionnaire. Many of these students attended state schools (84%) that offered free meals. After completing a science-action, the majority of students agreed that learning science will be useful in their daily lives and science helps people (64%). They also saw the importance in maths and science for solving problems (82%).

Qualitative data indicated various benefits for young learners with the CARE- KNOW-DO resources, for example, using their intrinsic motivation to explore and expand their knowledge. One student aged 12 commented "*what I learned with connect science project is to delve deeper into things that interest me and always have the motivation to learn".* This indicates students connect with science if it is based on something they are interested in. This is a key approach for the CARE phase by which students create questions, discuss issues, present ideas and map their views about socio-scientific issues that they care about.

In the KNOW stage, students expressed their enjoyment and interest in expanding their knowledge by discovering new things. One student aged 13 told us they think science is important "*To find out things which I didn't know before*".

In the DO phase, various students indicated that they like to take action and learning by doing, as shown by a student aged 14 *"I like projects and creating things in science, we work in groups, working with other people was fun".*

Just under half of students feel confident with their knowledge in science and in using science to come up with questions and ideas (48%). Most students felt confident doing science projects (67%) but only half felt able to talk about science (50%) and how to justify their views using arguments and evidence (49%).

However, around 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.

In terms of the importance of science in their lives, very few did science activities outside of school, with 77% reporting 'never or rarely'. This points to UK students having a low science capital, further supported to the fact that even though 62% of students felt that 'science is fun' (and 97% said they would like to do more activities like these) only 26% would like a job that uses science. This shows that even though the majority of students in the UK enjoy science, a minority will likely pursue science into higher education and beyond. Further work could be done on persuading students to pursue a scientific career.

Nearly half of students (49%) know someone working with science. As only 26% have parents who work in science, this highlights the positive impact the project had on their interaction with scientists. As one student commented: 'I learned from scientists that science can be enjoyable and fun.'

The following images show student work from the Energy Savers science action (figure 2 and figure 3)

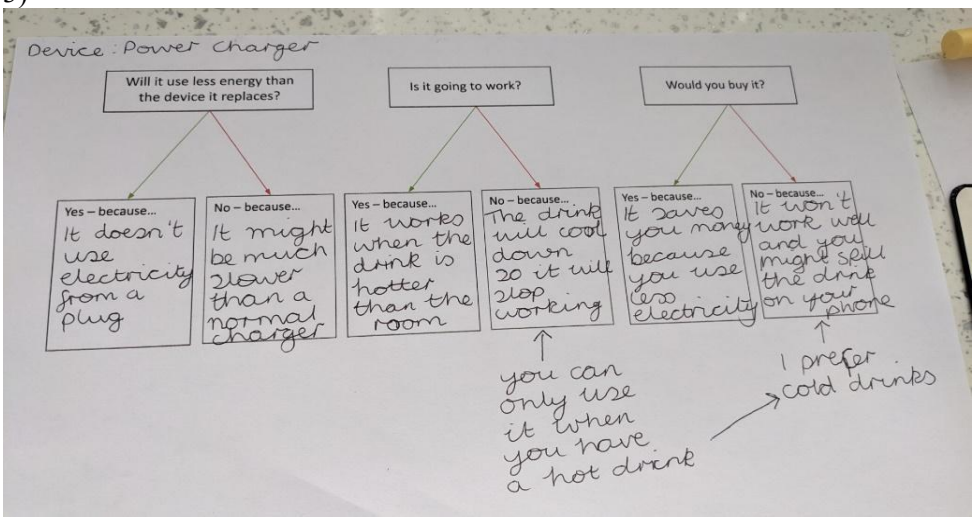

Figure 2: A decision tree used by a student to decide whether they would buy a charger powered by a hot drink.

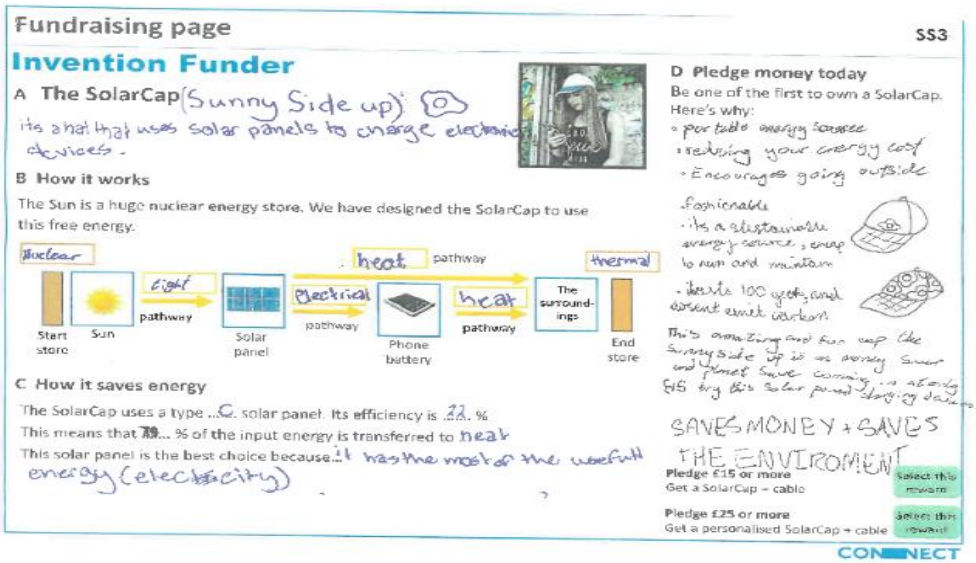

Figure 3: A fundraising campaign to raise funds to develop their chosen device – a solar powered cap.

Figure 3 was completed by a student aged 12. They added facts and opinions to the decision tree to help organise their thoughts. Using their knowledge of energy transfer, they correctly identified a flaw in the device, *'it works when the drink is hotter than the room, the drink will cool down so it will stop working'*. Because of this, they decided that they would not buy the device.

6. Conclusions

We have had great success with a significant number of teachers in UK but it has proved hard to scale up adoption of Open Schooling approaches in the UK. There are various significant barriers e.g. lack of teaching time, the pressure put on teachers from leadership to focus on exam success, risk aversion to anything new and not well understood by school leadership. Interventions at a school curriculum level like this have not been enough to produce sustainable change at scale. We also know from other work in the last few decades that interventions at a national level e.g., to the national curriculum are very difficult to achieve due to access to important stakeholders and a constantly changing policy environment.

One strategy that we are now pursuing is moving from only production of resources to the whole qualification. In the UK we are developing a concept of a "Science in practice" 14-16 qualification, which will sit alongside the traditional knowledge-based science course and aims to prepare students to make sense of and actively participate in contemporary science issues, through study of the nature of science and experience of carrying out enquiries. We are gaining support from teachers, scientists, and professional bodies. We also emphasize the crucial need for additional research grants to solidify the substantial work accomplished not only within CONNECT but also in all European Union-funded projects. This will contribute to strengthening and expanding the Open Schooling movement, with a significant impact toward achieving EU Missions and Agenda 2030 by 2030.

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Future-proofing science education using real-life issues in open-schooling

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Abstract. This paper outlines open schooling as an innovative approach to education that adequately prepares students for the future, both in terms of knowledge and skills acquisition. It presents the CONNECT project as an inclusive, engaging and future-oriented approach to open-schooling. The project resources include 'science-actions', based on real-life socio-scientific issues and a new pedagogical framework (CARE-KNOW-DO) that increases active engagement and supports problem-solving in the classroom. The findings of the project, used by teachers across Europe and Brazil, show that its aims of improving knowledge and skills, increasing effective engagement, raising aspirations, and promoting science in student's lives were met, and highlights the transformative potential of open schooling.

1. Introduction

Is a traditional transmissive curriculum adequately preparing our children? In a constantly evolving world where climate and sustainability issues are at the forefront as well as the advancing scope of technology, what changes need to be made by us, as educators, to prepare them to be responsible citizens in an uncertain future?

Our argument is that a traditional curriculum is not able to meet their needs; it doesn't consider what issues students care about and what knowledge and skills they need to develop. Many students are also under-served (mainly those from a low socioeconomic background) lacking cultural familiarity with scientific thinking and adequate role models, with limited opportunities to engage with natural, formal and human sciences beyond formal education for shape better lives and desirable future.

These factors combined often lead to a significant number of students feeling a disconnect between what they learn in the classroom and what they experience in their lives. This can manifest itself as a disinterest in science, a feeling that it is 'not for me' and ultimately an unwillingness to pursue science into higher education, as a career and citizenship.

In CONNECT we introduced teachers from across Europe and Brazil, to an approach – open schooling, which aims to address these concerns. We combined this with a new pedagogical framework for open schooling teaching – CARE-KNOW-DO. Both can be used in primary and secondary classrooms to help increase affective engagement and inspire students to explore the world through the lens of science and scientific thinking.

Our aims were to:

- Introduce teachers to the benefits of open-schooling.
- Implement a pedagogical framework for science teaching (CARE-KNOW-DO) that increases active engagement and supports real-life problem-solving.
- Improve the knowledge, skills and aspirations of students, especially those that are under-served.

2. Principles: CARE-KNOW-DO framework

Open-schooling is about solving real-life challenges to enhance wellbeing and sustainability by bringing together students with teachers, scientists, family members and policymakers. In CONNECT we provided guidance to teachers taking their first steps into open-schooling by removing barriers and providing engaging, participatory approaches called 'science-actions'.

CARE-KNOW-DO (Fig. 1) aims to make science education more meaningful, engaging, and relevant for students by supporting problem-solving based on real-world issues and fostering a sense of ownership and agency in their learning process supported by professionals and family members.

As the name suggests, there are three stages:

Figure 1: CARE-KNOW-DO for open schooling in the CONNECT project

The CARE stage introduces students to the issue and sets a challenge. In CONNECT, we choose issues related to the environment and health, focusing on current and relevant topics that align with students' concerns and interests. Scientists, who are either invited into the classroom or featured in recorded interviews, discuss their research, and students are given a simple yet engaging activity to take home and share with their families to stimulate discussions about the issue.

The KNOW stage primarily involves formal teaching of the curriculum, emphasizing the acquisition of knowledge and skills necessary to understand the issue and participate in discussions regarding potential solutions. As students apply their newfound knowledge to the issue, they transition from surface-level understanding of scientific concepts to deep and transferable knowledge.

The DO stage represents the final phase, where students utilize their recently acquired knowledge and skills to collaboratively address the issue. They present their actions either verbally or in writing. These ideas may be discussed at home or at school, including conversations with scientists. Teachers utilize these presentations as means to assess comprehension and engagement.

We employed the CARE-KNOW-DO framework [1] to develop a collection of high-quality open schooling resources. These materials are user-friendly and inclusive, varying in length, making them suitable for a diverse range of classrooms, as illustrated in Figure 2. Collectively, they address a wide array of issues and curriculum areas, providing opportunities for learning and applying inquiry, mathematical, and communication skills.

Teachers have embraced these learning resources in their planning, whether for single lessons, extended projects, or comprehensive units of study. This adoption aims to enhance student participation in science

activities, enabling them to transition from passive learners to active participants who take on roles as investigators, critical thinkers, co-creators of knowledge, and problem solvers.

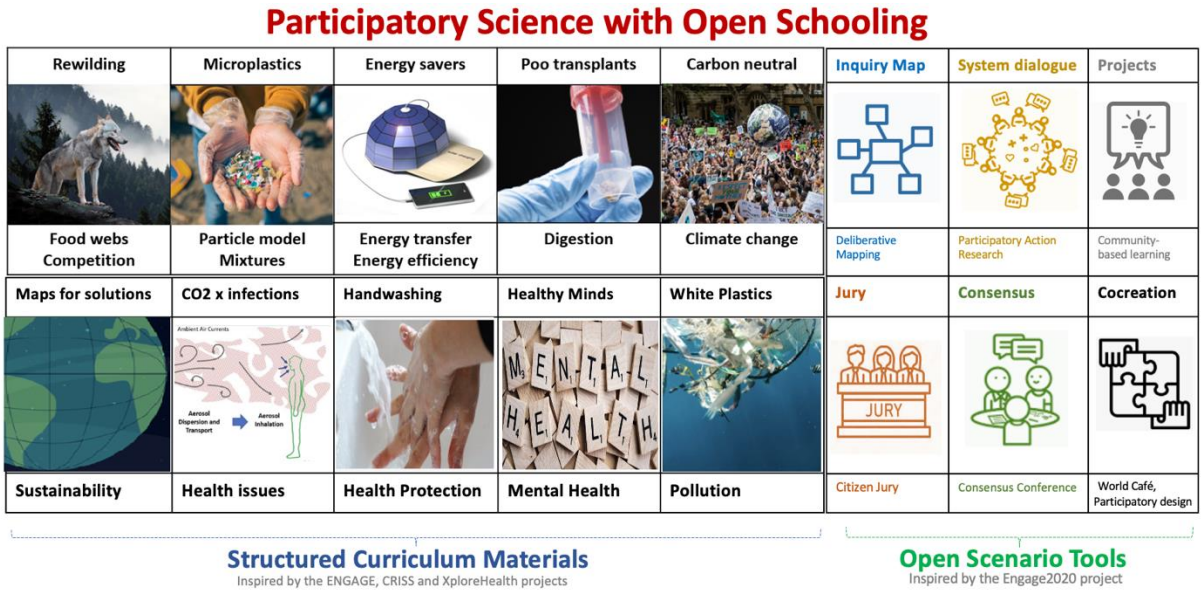

Figure 2: Some examples of CONNECT Multi-Language Open schooling resources

To create the open schooling resources, we used a 'backwards design' approach, where we started with the goals for each stage, and using research-based and participatory design pedagogies, created the activities that would achieve them. These resources grouped into two categories (structured curriculum materials and open scenario tools), freely available to download from the CONNECT platform https://connect-eu.exus.co.uk/category/english/, were extensively used by students integrated to their formal curriculum supported by teachers, non-formal experts from organisations and informal educators from families and local communities. These resulted in a a variety of science actions led by students in five countries. Some examples are available on CONNECT website (https://www.connect-science.net/best-practices/). As part of the open science approach with just-in-time feedback schools coordinators and their communities were able to access the project's report responded by teachers and by students available on the GoogleMap.

3. Methodology

The research approach of the CONNECT project prioritized the support of open schooling planning, implementation, and assessment, emphasizing refinement and evidence-based impact. Our approach, centred on a mixed methods study, aimed to inform both the scientific research community and research-based practitioners. Qualitative methods such as interviews and observations provided in-depth perspectives, while quantitative methods, supported by the CONNECT-science instrument, participatory science approaches [3] [4], were grounded in science capital and affective engagement [5], facilitating scalability. Access to evidence from mixed-method studies proved essential for educators and policymakers, enabling them to make informed decisions regarding the adoption and sustainability of open schooling within their organizations.

4. Key findings

More than 30,000 students took part in a CONNECT open-schooling project. A total of 16,716 students-participants across Europe and Brazil aged between 7 and 19 completed their science actions and completed the CONNECT research instrument on a voluntary basis. Linking to our aim of promoting open schooling with under-served students, most attended a state school (95%), only 18% had parents

in jobs that use science, 50% didn't do science activities outside of school and 31% didn't have access to the internet at home [5].

4.1 CONNECT platform

A large number of educators from formal and non-formal sectors including teachers, academics, researchers, scientists, teachers' educators, policymakers such as school heads and science coordinators totalise 1751 members, with an increasing number in phase 3 (2023)

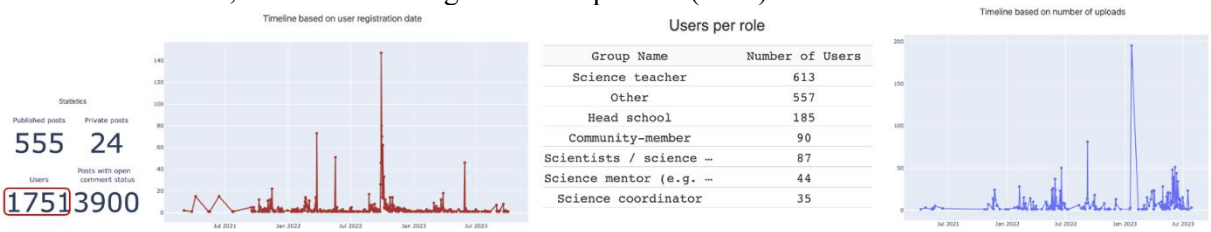

Figure 3: CONNECT platform Analytics

4.2 CONNECT Social Media platform

CONNECT website connected with social networks established collaborations with a large number of national organisations GO and NGO, including an increasing number of followers in social media (table 1)

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**

Table 1: CONNECT website and social media

4.3 CONNECT Best practices.

Figure 5 shows two examples of a science action focused on Rewilding. The real-life issue is the controversy over rewilding projects where extinct animal species are reintroduced to ecosystems for the benefit of wildlife, people, and climate. The Rewilding science-action encouraged students to use their understanding of interdependence and evidence analysis skills to plan a campaign promoting the rewilding of an animal into their country forests.

The activities designed, parts of which are shown as Figure 5 on the left, included examining how the reintroduction of wolves into an elk-populated national park restored the biodiversity balance, using a woodland food web to predict the effects of rewilding on the ecosystem's organisms and analysing data collected by scientists on the effects of the rewilding of beavers into a UK river. Figure 5 on the right shows an inquiry map produced by AI to explore these Brazilian students' questions "*Can the reintroduction of a specific animal in the Pantanal increase tree and plant fruit production, benefiting the food web and potentially leading to a higher number of birds and mammals in the ecosystem? Which animals are recommended for this purpose?"*

In carrying out these tasks, students applied their knowledge of food webs and competition to gain a deeper understanding of the concepts as well as practicing analysing data using inquiry mapping [5] based on local habitats and issues faced in their countries, learning how to weigh up evidence for conclusions and writing a persuasive argument.

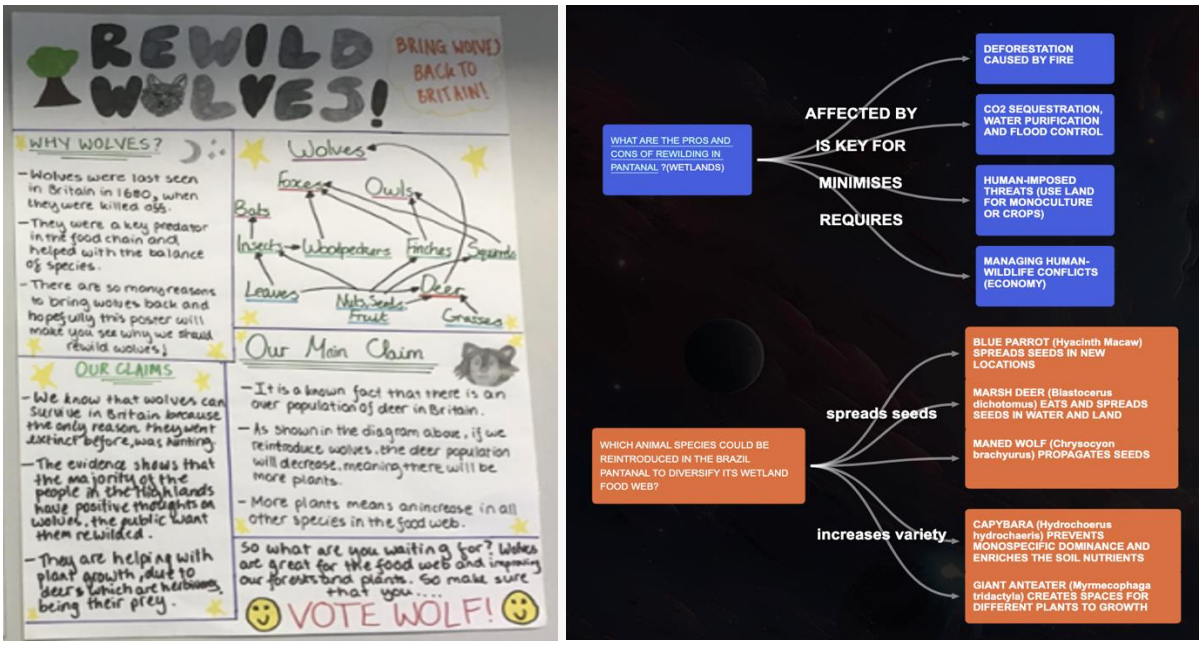

Figure 5 (Left): "Rewilding Wolves to restore UK forests" by British students' paper campaign (and Right) "Rewilding Peccary(Queixada) to restore Wetlands" by Brazilians' digital campaign [5]

4.4 CONNECT-science instrument

A summary of the key findings is shown as Figure 6 with a total of 16716 students (October 2023).

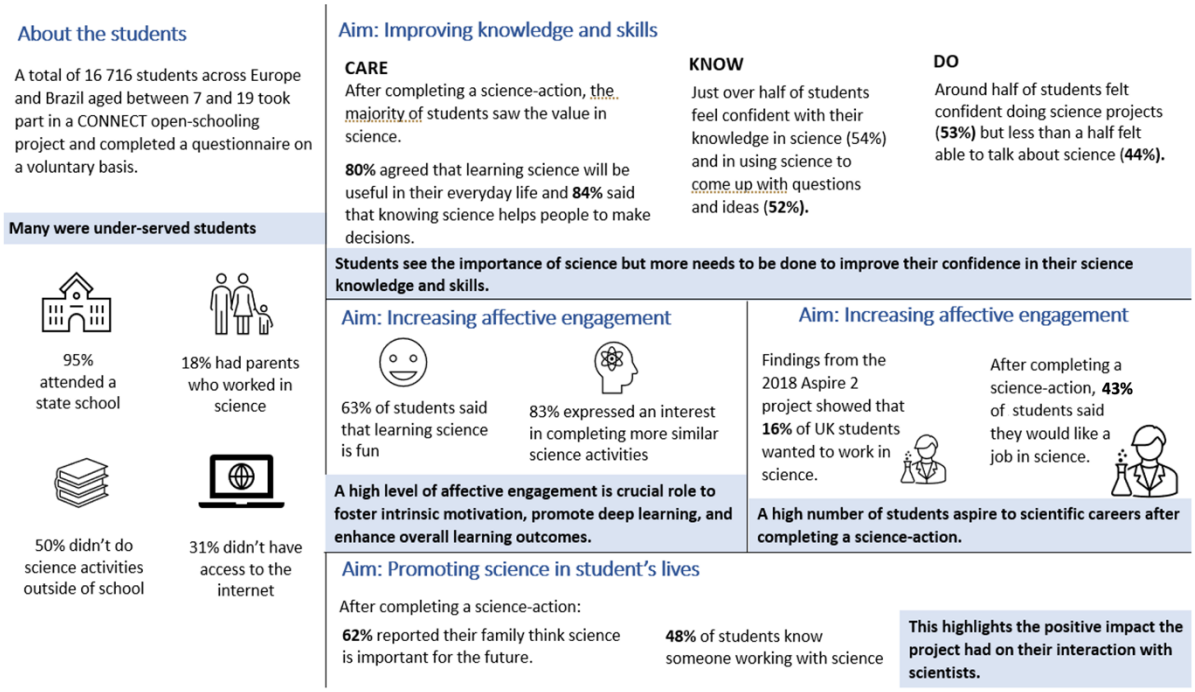

Figure 6: Key findings from the CONNECT project

Quantitative findings indicate four key benefits described as follows.

1. Improving knowledge and skills

CARE: After completing a science-action, the majority of students saw the value in science with 80% agreeing that learning science will be useful in their everyday life and 84% reported that knowing science helps people to make decisions.

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.

2. Increasing effective engagement

63% of students said that learning science is fun, with 83% expressing an interest in completing more similar science activities.

This high level of affective engagement is crucial role to foster intrinsic motivation, promote deep learning, and enhance overall learning outcomes.

3. Raising aspirations

43% of students said they would like a job in science, with 39% saying they would like to be seen as a science expert.

This highlights just how successful CONNECT has been in raising aspirations. The Aspires 2 project carried out by UCL in 2020, showed that just 16% of UK students aged 10-18 aspired to work in science [2].

4. Promoting science in students' lives

After completing a science-action, most students reported 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.

Qualitative findings complement and offer detailed insights into the outcomes that have had an impact on students' learning experiences and their connection with science in their daily lives, as described below. The teachers and students who participated showed great enthusiasm for the utilization of open schooling and its advantages. They emphasized multiple educational benefits, including increased parental involvement, enhanced student progress, the presence of scientists, the notion that science can be enjoyable and entertaining, improved group work and independent data retrieval skills among students, heightened awareness of science-related careers, the recognition that scientific knowledge is empowering, enhanced comprehension and self-efficacy in science, the ability to formulate more precise and insightful questions, a greater commitment to environmental care, as well as heightened engagement, curiosity, and active participation.

> "**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. "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
>
> "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 Brazil.
>
> "I 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 Brazil Northeast
>
> "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 Brazil SoutEast.
>
> "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.

“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

5. Conclusions

Our findings from the CONNECT project highlights the transformative potential of open schooling, and also highlights several important questions:

- How can we encourage more schools to adopt aspects of open schooling?
- What strategies can be implemented to effectively incorporate scientific issues that students care about into the curriculum?
- How can we further strengthen links between students, teachers, families and scientists to raise aspirations within science?

These questions will underpin the next phase of our work.

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Integrating "CONNECT" science actions into biology lessons of secondary school classes

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Abstract
The purpose of this article is to present two examples of the implementation of CONNECT scientific actions, in biology lessons, to secondary school students, respecting the school curriculum.
CONNECT activities provides innovative, participatory teaching approaches based on the active involvement of students and their families, which can stimulate their interest in science and technology and, why not, the desire to pursue a scientific career.
As a secondary school biology teacher, I implemented the scientific actions "Renaturalization" and "Carbon Neutral", in the fifth grade and eighth grades, as an integral part of the biology lessons, respecting the school curriculum.
The activities corresponding to the scientific action "Renaturalization" were integrated in the fifth grade in the lessons belonging to the learning unit "Living things from the near and more distant environment - relationships between living things, the importance of living things for nature and human".
The activities corresponding to the "Carbon Neutral" scientific action were integrated in the eighth grade in the lessons belonging to the "Human and environmental health" learning unit.
The students were very interested in the debated topics, learned new investigative skills, learned to solve problems "step by step", showed creativity, responsibility and maturity in decision-making, acquired the ability to analyze the consequences of the decisions made. They worked as a team, tried to convince their families that the actions proposed by them are the best solutions for solving the discussed problems.
The benefits of implementing CONNECT can be summed up in three words: knowledge, skills, attitudes.

Keywords: scientific actions, renaturalization, neutral carbon, secondary school students, school curriculum

The concept of "Open schools for Open Societies" is an educational concept that revolutionizes education systems and is applied more and more in schools in Romania. It involves the active involvement in the educational processes of students, teachers, parents, specialists in the field but also of the local community, thus contributing to the development of society as a whole. If we compare modern and traditional education, we can say that the main difference is that modern education promotes a formative education, focused on the individual particularities of students, on their needs and interests, the teaching staff acting as a facilitator of learning, while, traditional education promotes an informative education that is focused on the activity of the teacher, this being the source of information and having a dominant role.

The traditional education system focuses on explanatory-receptive-reproductive learning, while the modern education system is based on active-participatory learning, the student being constantly looking for new information, in his field of interest.Teaching science by integrating „ scientific action " as a complement to the activities of the school curriculum, facilitates the development of basic skills in science and technology in schools in Europe, European-recognized competences (European Commission / ECEA / Eurydice, 2012).

The CONNECT PROJECT is funded by the European Commission (2020-2023) under the grant agreement no. 872814. CONNECT activities offer innovative, participatory teaching approaches based on the active involvement of students and their families, which can stimulate their interest in science and technology and, why not, the desire to pursue a scientific career.

CONNECT scientific actions propose didactic scenarios based on the following three stages: CARE , KNOW 1, KNOW 2 , DO. They can be introduced by science teachers in lessons and can be adapted to the level of knowledge and understanding of students.

The concept of CARE, requires the science teacher, to stimulate students' interest in the topic approached, so that students become motivated, "to care" and of course to understand the scientific concepts they will use during their activities.

KNOW1 is an approach that allows the applicati on of knowledge acquired in new contexts.

KNOW2 develops in students the skills needed to analyze the existing evidence in support of statements

DO involves evaluating the performance of students by coordinating the knowledge and skills acquired by them in the scientific field.

As a biology teacher at the gymnasium, in the period 2020-2023, we implemented the scientific actions „Renaturalization" and „Carbon Neutral", in the 5th and 8th grades, as an integral part of biology lessons, respecting the school curriculum .

The scientific action "Renaturalization" is designed to be integrated into the topic of interdependence between species. Thus, we integrated the activities "Renaturalization" in the biology lessons belonging to the learning unit "Living things from the near and more distant environment - relationships between living things, the importance of living things for nature and human" in the 5th grade (students aged 10-11 years).

The activities took place after the scenario CARE, KNOW, DO.

1.Initial testing of students' knowledge;

2.Wolf renaturalization in the UK: Student motivation; Understanding the scientific context; Applying knowledge about trophic relationships in a new context;

3.It's your turn: Solving similar problems, independently (Imagine the renaturalization of these animals in Romania: bison, laughter, bear. What effect would the renaturalization of each have on the ecosystem? Explain which animal would have the most positive effects on the ecosystem).

4.Renaturalization campaign: Students launched a campaign to persuade the public - pupils, teachers, parents, the local community, that the animal they choose must be renaturalized. To make the presentations they used in the campaign, they collected and evaluated evidence, selected the most convincing statement using logical reasoning.

Photo 1

Photo 2

The activities corresponding to the scientific action „ Neutral Carbon ", we integrated them in the gymnasium biology program, in the lessons belonging to the learning unit „ Human and environmental health", in the eighth grade (students aged 13-14 years). The scientific action "Neutral Carbon" uses 2 key concepts: the Earth's atmosphere and global warming.

I followed the didactic scenario recommended by CONNECT, with the following learning activities:

1.Challenge: Students researched the notions of neutral carbon and carbon footprint. They calculated the carbon footprint of their household.

2.Carbon: Students found out how companies generate CO2 emissions and applied the information they gained to help a cafe find out how to produce CO2 emissions.

3. Game: Students have evaluated the actions that the cafe can take to reduce its carbon footprint.

4.Recommendations: Students drafted a plan that included their recommendations for the cafe so that it becomes carbon neutral.

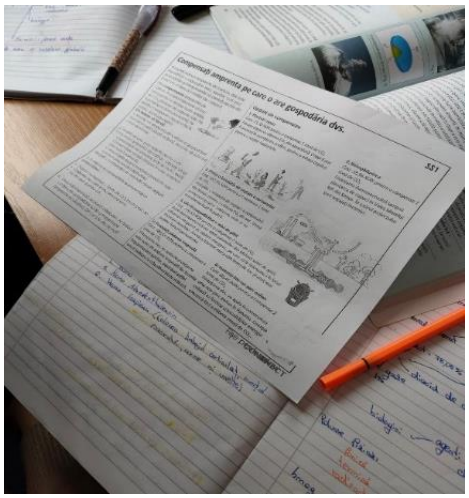

Photo 3

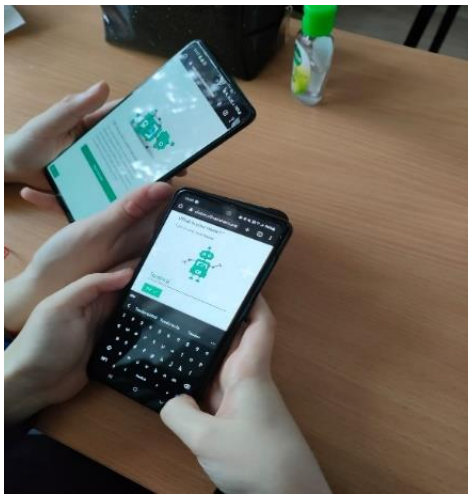

Photo 4

The students were very interested in the debated topics, learned new investigative skills, learned to solve problems "step by step", showed creativity, responsibility and maturity in decision-making, acquired the ability to analyze the consequences of the decisions made. They worked as a team, tried to convince their families that the actions proposed by them are the best solutions for solving the discussed problems.

The benefits of implementing CONNECT can be summed up in three words: knowledge, skills, attitudes.

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Lesson study in the context of open schooling for teacher education

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Abstract. This paper outlines an exploratory research work investigating the potential of Lesson Study for teacher professional development within the context of sustainability education in open schooling. Open schooling, a comprehensive learning approach, integrates formal, non-formal, and informal education, engaging students in addressing real-life sustainability challenges in collaboration with universities and communities. Despite its promise, open schooling remains relatively underrepresented in the literature, especially in relation to Lesson Study, STEM education, and the incorporation of real-life socioscientific issues. This paper reviews existing literature on these topics and provides recommendations for teacher educators seeking to enhance sustainability education within open schooling through innovative methodologies.

Keywords: Lesson Study, Open Schooling, Teacher Education, Real-life Socioscientific Issues.

1. Introduction

The concept of open schooling is often used more broadly and can encompass a variety of educational approaches and practices that promote openness, flexibility, and innovation in education. This term has been promoted by the European Union since 2015. Open schooling involves transforming schools into centers of well-being where students collaborate with their families, communities, and expert professionals to address real-life problems that contribute to sustainable development. This approach aims to nurture students' scientific thinking skills, fostering their problem-solving abilities and, in turn, cultivating a heightened interest in pursuing careers in the field of science [1]. In the CONNECT project, which focuses on inclusive open schooling with a forward-looking perspective on science education, open schooling is firmly grounded in engagement and enjoyable learning principles. It emphasizes education as a socially transformative and inclusive process that highly regards diversity and meaningful learning [2].

This article posits Lesson Study as a viable approach for supporting teacher education within the open schooling context. This action research teaching strategy was designed to foster classroom-based, engaging activities **to solve** real problems perceived by students, thus creating an enriching and enjoyable learning environment. Lesson Study, often abbreviated as LS, is presented as an alternative method to facilitate collaborative teacher professional development. Its core purpose is to enhance the quality of education and address learning challenges [3]. The LS concept revolves around a teacher professional development model rooted in collaborative learning, emphasizing principles of mutual learning to continually enhance teaching practices [4], [5].

In this study, our primary objective is to investiga**te the potential of LS** in raising awareness of sustainable development within the framework of open schooling. Our specific research questions (RQ) encompass the following:

- (RQ1) In what ways Lesson Study could be implemented for teacher education in the context of open schooling?

- (RQ2) In what ways existing literature regarding Lesson Study in science education could be used to inform teachers' educators interested in open schooling?
- (RQ3) What are the similarities between Lesson Study and the coaching model SEEK used in the CONNECT open schooling project?

2. Methodology

Our methodology centred on: • A scoping review conducted using academic databases such as Scholar and Emerald Insight. • Inclusion criteria: Articles published in English in scientific journals within the past five years. • Exclusion criteria: Book chapters, reviews, handbooks, and studies that did not investigate LS and its application to scientific issues.

In the assessment process, a total of 41 articles were reviewed to determine their relevance to the study's objectives. Out of these, only three articles were found to meet the inclusion criteria, demonstrating the selectivity of the research process.

These three articles focused on various issues related to science education and pedagogy. The primary themes analysed within these selected articles included scientific literacy and communication skills, scientific argumentation, and science thinking skills. This deliberate focus on key aspects of science education allowed for a comprehensive exploration of the effectiveness of LS in enhancing these critical skills.

The nature of the studies in the selected articles varied, demonstrating a diverse approach to investigating the impact of LS on science education. The research designs included descriptive-qualitative methods, a mixed-method approach, and purely qualitative methods. This methodological diversity enriched the depth of insights and perspectives available for the study, providing a well-rounded understanding of the subject matter.

Additionally, these studies were conducted in different countries, showcasing a global perspective on the implementation of LS in science education. The countries where the research took place were China, Norway, and Indonesia. The geographical diversity of the studies further emphasized the universality and adaptability of LS as an approach to improving science education. This cross-cultural dimension added valuable insights into the effectiveness of LS in diverse educational contexts, enriching the study's findings.

3. Findings

(RQ1) In what ways lesson study could be implemented for teacher education in the context of open schooling?

According to [6], educators engaged in LS in Japan and the United States demonstrated that participating professionals benefited from successful LS practice in seven ways: deepening their knowledge of the subject studied, gaining a better understanding of instruction, improving their ability to observe students, forming stronger professional networks, establishing a stronger connection between daily practice and long-term goals, increasing motivation and a sense of efficacy, and enhancing the quality of lesson planning.

LS is conducted iteratively and can occur in a cyclical manner through four phases [7]. Traditionally, LS is implemented with groups of teachers who together go through four collaborative steps: i) curriculum study and goal formulation; ii) planning, which involves the selection and detailed review of the research lesson; iii) teaching, where one team member teaches the research lesson while others observe and collect data; and iv) reflection on their own practice and beliefs to enhance it [3], [8], [9], as demonstrated in Figure1.

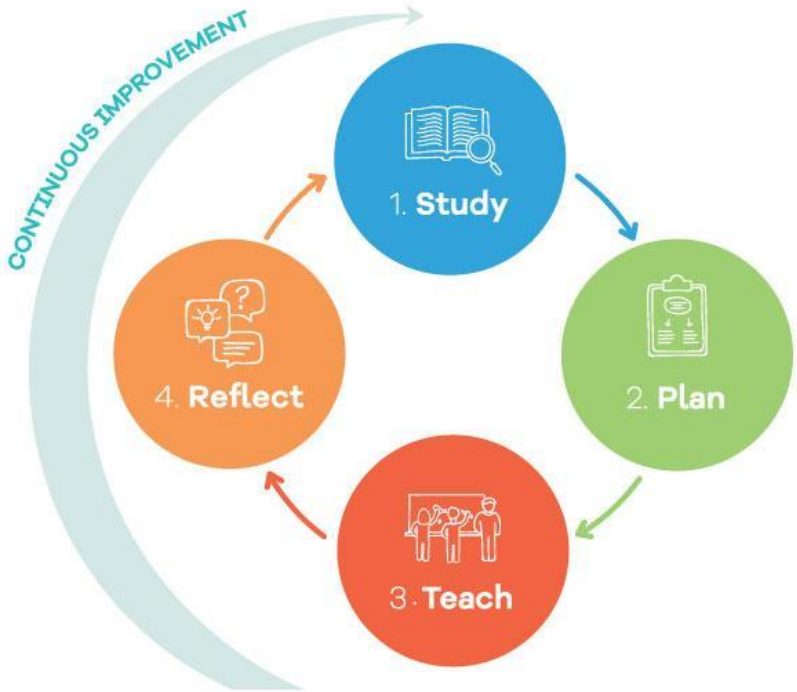

Figure 1. Source: The Lesson Study Group at Mills College [10].

(RQ2) In what ways existing literature regarding Lesson Study in science education could be used to inform teachers' educators interested in open schooling?

In investigating the effectiveness of contextual learning for scientific attitude and student performance in Natural Sciences, [11] suggest the adoption of the LS approach to counter conventional teaching, where teachers, possibly due to a lack of knowledge about alternative teaching methods, continue to provide rigid and ready-made instruction. According to these authors, LS is suitable for promoting cooperation among teachers to observe their own practices and collaboratively develop strategies to foster an active stance in students. The goal is for student-centered learning to increase their interest and promote healthy and positive social interaction to achieve learning objectives while enhancing critical thinking skills for contextual scientific issues among students.

In a similar vein, in the Netherlands, the Freudenthal Institute has partnered with a team of high school science teachers to promote sustainability education following the LS approach. In this initiative, science teachers and researchers explore the opportunities of socioscientific inquiry-based learning to facilitate the planning of lessons on environmental citizenship and address the challenge of preparing students to form responsible opinions on such topics [12]. This issue concerns the knowledge about and of science that citizens need to critically consider scientific findings and analyze the complexity of socioscientific issues in order to make informed decisions in their daily lives, taking into account different values [13].

In a recent international systematic review study, [14] analyzed the implementation of socioscientific issues as teaching and learning materials in science education and how different stages are developed in the learning process. The findings indicated that primary studies implementing LS achieved successful results both in terms of teacher professional development and student learning improvement. The study emphasizes that the difference lies in the fact that while most implementations of socioscientific issues are focused solely on student learning, initiatives that adopt the LS approach promote a sustainable cycle of actions aimed primarily at teacher professional development, which is rare in this area. Therefore, the successful integration of science learning in the educational context is inseparable from the teacher's or facilitator's ability to apply it. These initiatives have shown that investing in developing teaching skills

to work collaboratively on socioscientific issues, from planning to teaching, observation, and analysis of learning and teaching, directly reflects in better student learning outcomes.

It is observed that the implementation of socioscientific issues in educational contexts varies in different countries and cultures or traditions. Therefore, problems related to socioscientific issues that arise in one country may simply not exist in others [15]. Thus, socioscientific issues differ from other scientific issues because they are open, unstructured, and contextual problems [16]. They are open because they lack a direct answer or solution, and unstructured due to their controversial nature, as well as potentially having scientific explanations and connections to various other areas of knowledge [15].

(RQ3) What are the similarities between Lesson Study and the coaching model SEEK used in the CONNECT open schooling project?

Given the open-ended nature of LS and Coaching scenarios, it is crucial for teachers to engage in collaborative discussions about their individual requirements, challenges, interests, and effective strategies. These discussions serve to foster the exploration and implementation of scientific topics tailored to local needs. The success or obstacles in implementing and discussing socioscientific issues in teaching and learning processes depend on teachers' perceptions of their feasibility. The LS approach provides an opportunity for teachers to reflect on their long-standing practices and begin to form new beliefs related to creating a meaningful learning atmosphere in an open schooling context. However, studies on how the implementation of socioscientific issues in the open schooling context can be supported by the LS approach are limited.

According to [17], efficient teacher training is crucial for overcoming pedagogical difficulties already experienced by teachers and for the appropriation of new pedagogical strategies in an unfamiliar open schooling context. To facilitate the development and monitoring of the LS approach, the coaching model called SEEK (acronym for Start, Establish, Explore, Key) suggested by [18] for personalized teacher training in the open schooling context can be used during the complexity process experienced by teachers. The LS approach and SEEK have congruent and complementary characteristics suitable for the open schooling context.

The SEEK model also consists of four stages: i) the start, which aims to build trust for the process, where goals and expectations will be aligned; ii) the exploration and establishment stage of a new perspective allows participants to recognize where they are and what needs to be done to achieve established goals; iii) the stage of exploring options and action planning aims to understand potential pathways that will allow the achievement of goals and identify feasible deadlines for the completion of proposed tasks; iv) the recognition of major achievements is the final stage of the process, where participants have the opportunity to reflect on the progress made and, by identifying key results, each member should be encouraged to acknowledge their effort and achievements [18]), as shown in Fig. 2.

Both LS and the SEEK coaching model share a cyclical and iterative approach, organized into distinct stages. LS traditionally comprises four collaborative phases: curriculum study and goal formulation, planning, teaching, and reflection. Similarly, the SEEK coaching model also consists of four stages: start, exploration and establishment, exploring options and action planning, and recognition of major achievements. In both models, the iterative nature allows for continuous improvement, and the structured phases facilitate the collaborative development and reflection of teaching practices, ultimately enhancing the professional growth of educators.

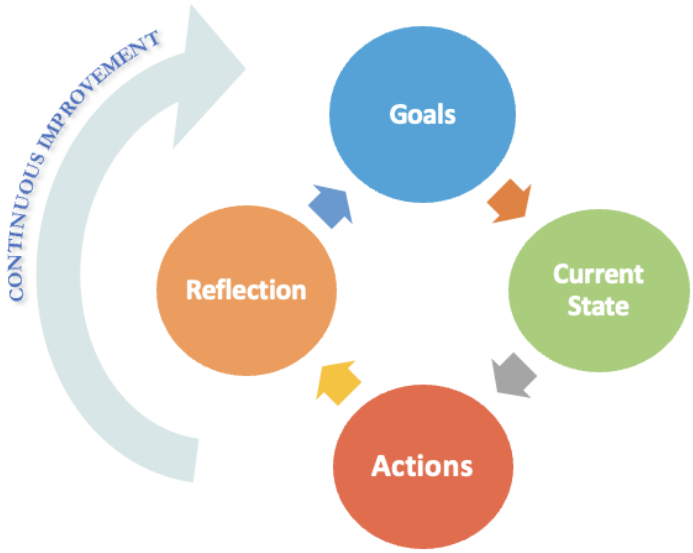

Figure 2. Source: CONNECT SEEK coaching model (2022).

Conclusion

In conclusion, this article has explored the potential implementation of LS within the context of open schooling, with a particular focus on enhancing science education. The research has highlighted how LS, a well-established action research teaching method, can offer valuable insights and benefits to teachers and students involved in open schooling initiatives.

LS, conducted iteratively and often in a cyclical manner through four distinct phases, has been demonstrated to bring about several positive outcomes. These include deepening teachers' subject knowledge, improving their understanding of instruction, enhancing their ability to observe students effectively, fostering stronger professional networks, strengthening the connection between daily teaching practices and long-term goals, increasing motivation and self-efficacy, and elevating the quality of lesson planning.

Furthermore, the study has delved into the existing literature regarding LS in the context of science education and how this body of knowledge can inform teacher educators interested in open schooling. This review has showcased successful applications of LS, particularly in promoting science education, by encouraging cooperation among teachers and enhancing critical thinking skills, student engagement, and problem-solving abilities. The research also highlighted the need for teacher professional development to ensure successful implementation. Additionally, the article has drawn attention to the similarities between LS and the SEEK coaching model, as both models share a cyclical and iterative approach structured into distinct stages. This similarity underscores their compatibility and the potential for their collaborative use in open schooling contexts.

Overall, the findings suggest that LS, with its well-documented benefits, has the potential to be a valuable tool for promoting open schooling, enhancing science education, and providing teachers with the means to collaboratively address real-world issues while fostering student engagement and problem-solving skills. Furthermore, the congruence between LS and the SEEK coaching model offers a promising avenue for supporting teacher development in open schooling initiatives, ultimately contributing to the success and sustainability of this educational approach.

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Health risks by (micro)plastics in food: Towards a sustainable attitude change in consumer behavior

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Abstract. The present work highlights an approach towards sustainable consumption awareness and attitude change in consumer behavior related to the selection, use, disposal and/or recycling of food packaging. An intervention is designed aiming to lead high school students in adopting a sustainable consumer behavior/lifestyle and increase their science capital. Students cooperate with their families and with scientists in the field. Specific goals and targets of the United Nations' 2030 Agenda for Sustainable Development are taken into account. The implementation of the Care-Know-Do framework for open schooling, supporting the intervention, is demonstrated. An attitude change evaluation process is also proposed.

7. Introduction

A significant fraction of the global plastic production is related to food packaging [1-3]. Chemicals found in plastic packaging span a wide and diverse set of materials and origins. Besides the various polymers used, there are also substances deliberately added by the manufacturers, i.e., plasticizers, dyes, lubricants and others, in order to produce plastics with desired properties. Furthermore, non intentionally added chemicals can accumulate as byproducts in food packaging, such as manufacturing residues, monomers, oligomers and other impurities.

Health risks do not only originate from food contamination due to its contact with plastic packaging. Materials used in everyday activities such as clothes, paints, bags, bottles, straws, microbeads for cosmetic, personal care and cleaning products, even tire dust can release microplatics to the environment. Microplastics are microparticles less than 5 millimeters in size [1] that invade in the food chain usually being undetected.

Besides the widespread use of plastics in food packaging and the possible threats to human health, motivating factors for this work have also been: i) The need to raise awareness and comply with the global goals for sustainable development, ii) The availability of bioplastics and biodegradable plastics that could replace the conventional plastics used in food packaging [4], iii) The necessity to update the current recycling patterns in order to include recyclable bioplastics, iv) The significance of packaging labels awareness towards responsible use, deposit/recycling, v) The availability of the infrastructure and

the expertise of the University of Crete which can enhance the science capital of students as well as their interest and confidence in science and vi) The challenge to change human behavior.

According to United Nations' 2030 Agenda for Sustainable Development, the 17 Sustainable Development Goals (SDGs) are an urgent call for action by all countries in a global partnership for peace and prosperity [5]. Among the SDGs of the 2030 Agenda, the design of the intervention to high- school students and their families presented in this work focuses especially to goal 3: *Good health and well being*, goal 4: *Quality education*, goal 9: *Industry, innovation and infrastructure* and goal 12: *Responsible consumption and production*. The targets under consideration associated with these goals are listed in Table 1.

Table 1. Targets of sustainable development goals (SDGs) that shaped the structure of the intervention presented in this work

Goal	Target
3	3.9 Reduce illnesses and death from hazardous chemicals and pollution
4	4.7 Education for sustainable development and global citizenship
9	9.4 Upgrade all industries and infrastructures for sustainability
	9.5 Enhance research and upgrade industrial technologies
12	12.4 Responsible management of chemicals and waste
	12.5 Substantially reduce waste generation
	12.6 Encourage companies to adopt sustainable practices and sustainability reporting
	12.8 Promote universal understanding of sustainable lifestyles

The first approach of actions regarding the sustainable use of plastic, in compliance with the abovementioned SDGs, is the approach of 3R's: REDUCE, REUSE, RECYCLE. A second approach is the use of biodegradable polymers. The use of (bio)degradable plastics and bioplastics could, under certain conditions, provide solution to the food contamination and microplastics pollution problem and comply with the SDGs and the associated targets. Biodegradable polymers can be completely degraded by bacterial decomposition being converted into water, CO_2, N_2, inorganic salts as well as biomass. In this sense, after decomposition they return back to nature as a set of natural byproducts. Bioplastics can be one or a combination of the following [4]: i) monomers derived from renewable resources (biomass) and subsequently polymerized chemically, ii) polymers extracted from biomass, iii) biodegradable polymers/plastics and iv) plastic material produced through biological procedures. In general, the raw materials for bioplastics can be:

- Starch and sugars (corn, potatoes, rice, sugarcane)
- Fat and oils (oilseed rape, castor oil, soya oil)
- Cellulose (wood, cotton)
- Proteins (chitin, wheat gluten, silk)
- Biomass

The oceans' algae also appear as a promising raw material candidate containing polysaccharides and reproducing very fast all the year without interference in the food chain. Although not all bioplastics are biodegradable, they are derived from renewable resources. Conventional plastics, on the other hand, are usually derived by fossil fuels. They are often non degradable. Based on non renewable resources, more than nine million barrels of fossil fuel are needed daily for the plastic we are using. This excessive use of fossil fuels also contributes to the global warming.

Environmental issues appear in the use of bioplastics as well. The bioplastics production strongly depends upon oil fuel, which is needed as energy source for the operation of agricultural machinery, farm watering, product transportation e.t.c. For the production of 1kg of bioplastic, 0.5kg of oil fuel is needed and an energy amount corresponding to the 80% of the energy needed for PE production is

consumed. The bioplastics production is sustainable in the sense that reduces the carbon dioxide emissions compared to the conventional plastics production but on the other hand it can lead to deforestation, changes in the water cycle and soil erosion. A possible solution could be the production of bioplastics by agricultural or livestock farming waste, non edible biomass or bio-organisms.

8. The intervention

The awareness raising and attitude change procedure is facilitated by the use of the Care-Know-Do scheme of the CONNECT project [6]. High school students along with their families act as researchers gathering information regarding the polymers used in food packaging and produce predetermined deliverables. The participants in each phase of the applied open schooling framework are listed in Table 2.

Table 2. Participants involved in each phase of the care-know-do implementation

Phase	Participants
Care	Instructor, Students, Student Family Members
Know	Instructor, Scientists, Students, Student Family Members
Do	Instructor, Students, Student Family Members

At the care phase, students and their family members are encouraged to follow a two-level approach. At the first level, they familiarize themselves with the notation of the seven recycling symbols as well as with the labels indicating (bio)degradable plastic and associate these symbols with the food and beverage plastic packaging found at their homes. At the second level, they expand their research to prepare lists and make links between different polymers and food/beverage packaging found at supermarkets and foodservice establishments.

In order to boost the awareness raising and the attitude change efficiency of the intervention, comprehensive data and guidelines are provided to the students during the care and know-steps, which are related to the hazardous chemicals that can be released from packaging and contaminate our food. These potential risks may originate from the manufacturing, use or disposal/recycling life-phase of the packaging. The students are actually involved in the investigation of the following issues:

- Why is the use of plastic materials in food packaging/containers so widespread worldwide?
- Which properties of plastics made them so popular in everyday use?
- What information can we extract from the resin identification codes?
- Is temperature, mechanical stress or radiation affecting the safety of plastic food packaging/containers? Are there plastics that withstand high ambient or food temperatures?
- Can plastic food packaging/containers be safely used in conventional ovens, microwave ovens and/or dishwashers?
- How can plastic packaging and plastic containers contaminate our food?
- Can we find other materials to replace plastic materials for food packaging and containers?
- Are biodegradable bioplastics the solution?

The students, realize the threefold origin of hazardous chemicals and microplastics release and are encouraged to adopt a corresponding three level sustainable consumption action: 1. appropriate food packaging selection, 2. sensible use and 3. responsible disposal/recycling. Furthermore, the pros and cons of proposed solutions to the plastics problem, such as usage of recycled, reusable, or bio-based and/or biodegradable plastic, or switching to other materials in food packaging, are investigated.

At the Do-step, the students work in teams to produce deliverables associated with the consumer action guidelines (SDG:3) and a roadmap of sustainable consumption (SDGs:3,12). They disseminate their findings and outcomes in the form of digital posters and presentations, participate in related conferences and make interventions to the policy makers and/or the chemical industry (SDGs:9,12).

9. The behavior change

An integral part of the attitude-change intervention proposed in this paper is its evaluation. The proposed model is an adaptation of the Transtheoretical Model (TTM) known also as the Stages of Change Model [7]. Based on the identification of the steps of behavior change, it provides an effective framework to describe the status of change implementation. Using checklists and interviews with participating students, the evaluator seeks for evidence regarding their motivation and their ability to change and identifies the stages of change achieved.

Critical to the attitude-change and intervention success assessment, is the post-evaluation of the students' change-maintenance and their determination to follow the goals of sustainable consumption.

The stages of change, accompanied with identifying examples for the case of change in consumer recycling behavior, are the following:

- **Precontemplation** (Not realizing the existence of a problem behavior and the need to be changed: "*I have no intention of starting recycling plastic*")
- **Contemplation** (Realizing the problem existence but not yet ready to make a change: "*I might start recycling*")
- **Preparation/Determination** (Getting ready to change: "*I will definitely start recycling*")
- **Action** (Changing behavior: "*I have started recycling*")
- **Maintenance** (Maintaining the behavior change: "*Recycling has become an integral part of my lifestyle*") and sometimes
- **Relapse** (Going back to a previous stage or completely abandoning changes: "*I am no longer recycling since it was a time consuming task*")

Relapse, as can be seen in Figure 1, is not a state. It is actually a recycling process involving return from the *Maintenance* or *Action* stage to a previous stage.

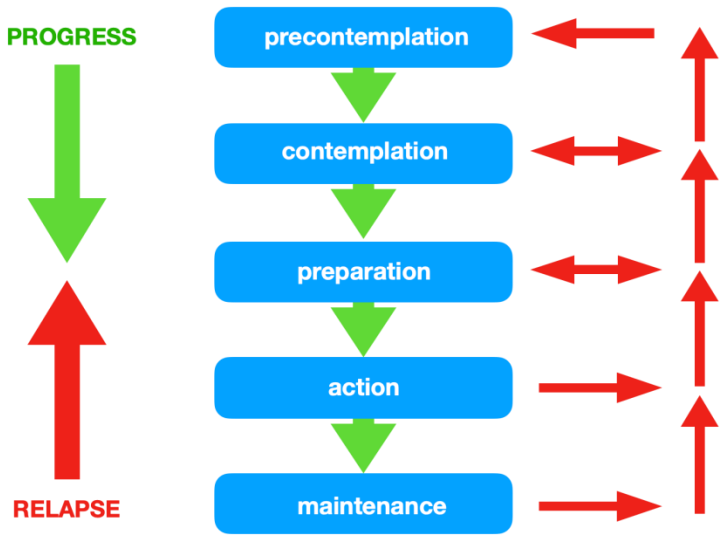

Figure 1. The Stages of Change (Transtheoretical) Model

In order to assess readiness to change regarding recycling, a set of closed ended questions were developed and are listed in table 3. The students had to respond selecting/receiving the following options/scores: i) Strongly disagree/(-2), ii) Disagree/(-1), iii) Not sure/0, iv) Agree/1, v) Strongly agree/2

Table 3. Assessment of readiness to change. P: Precontemplation, C: Contemplation, A: Action

Items to be scored	Stage of Change
I am trying to recycle more often than I used	**A**
I am using plastic food packaging but unfortunately I usually ignore recycling	**C**
Sometimes I think I should start recycling	**C**
It's a waste of time trying to recycle	**P**
I don't think I am underestimating recycling	**P**
I have just recently put recycling in my lifestyle	**A**
People usually talk about the benefits of recycling, I am already doing something about it	**A**
I now believe I should think about beginning recycling	**C**
No-recycling can actually be a problem sometimes	**C**
Recycling is not a priority for me	**P**
I am beginning recycling right now	**A**
There is no reason changing my habits and begin recycling	**P**

Closed ended questions measuring Maintenance or Relapse as well as questions for the overall evaluation of the intervention are listed in Table 4.

Table 4. The stages of change and overall evaluation. M: Maintenance, R: Relapse

	Items to be scored	Stage of Change
1	I feel satisfied taking part in the CONNECT project	**-**
2	My participation in the CONNECT project enhanced my support to recycling	**-**
3	Due to the awareness I have gained by my participation in the CONNECT project I am now more likely to check the plastic food packaging labels before purchasing a food product	**-**
4	One year after my CONNECT experience, recycling has become an integral part of my lifestyle	**M/R**
5	One year after my CONNECT experience I am regularly checking the food packaging labels before purchasing	**M/R**
6	I am no longer anxious about checking the labels of plastic food packaging as I was doing during the CONNECT project implementation	**R/M**
7	I cannot afford the time to continue recycling anymore	**R/M**
8	My participation at the CONNECT project enhanced my interest about science	**-**

The overall evaluation of the intervention was also supported by open-ended questions such as:

- Which aspect of the "Plastics and food" educational scenario implementation did you find more difficult or less interesting?

- What was the most interesting or useful feature of the “Plastics and food” educational scenario implementation ?
- Please suggest any improvements to the “Plastics and food” educational scenario implementation

The abovementioned sets of closed and open-ended questions are suitable for determining the stage of change for each student during the intervention as well as after a sufficient time interval (six months, one year) in order to post evaluate the intervention and assess its effectiveness in changing consumer behavior. In our case, post evaluation after one year was implemented yielding encouraging results. In addition, the science capital of the students was found to be enhanced. Students also had the opportunity to become familiar with science and scientific research.

Commenting on the results, it is important to stress out that in the question "My participation in the CONNECT project enhanced my support to recycling" more than half of the students from a typical grade 11 class responded by "Agree" and "Strongly Agree". The participation of a team of students to the Panhellenic Student Conference of the CONNECT project was very fruitful and enhanced their interest in science. This enhanced interest has been detected by the students' responses to open-ended questions. The need for cooperation with students from other schools and other countries was another important issue revealed by the responses to the open-ended evaluation questions.

In order to more accurately evaluate the effectiveness [8] of the intervention and the proposed evaluation scheme, future work should test the intervention in new contexts scaling up and targeting new groups and populations such as, the parents participating in the CONNECT project.

10. Conclusions

We have demonstrated an intervention to high school students towards a sustainable attitude change in consumer behavior in compliance with SDGs of the United Nations' 2030 Agenda for Sustainable Development. The intervention is based on an educational scenario designed following the care-know-do framework of open schooling of the CONNECT Horizon 2020 project. Students are acting as researchers in a process where families, the educator and scientists are involved.

An evaluation method is proposed and implemented, based in the stages of change model of behavior change. One year after, the intervention post-evaluation is yielding encouraging results regarding the recycling of plastic behavior change and the effectiveness of the intervention. The implemented open schooling framework is found to enhance the science capital of the students and their trust, as well as their positive view, about science and scientific research.

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The benefits and challenges of mapping for students and teachers: geospatial technologies as a tool in open school education.

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Abstract Geospatial technologies, with an emphasis on mapping, are increasingly being recognized as highly important instructional resources inside open schools. They offer a multitude of benefits for both students and educators, facilitating the development of crucial cognitive abilities such as critical thinking, problem-solving, and spatial literacy while facilitating interdisciplinary learning, enhancing student engagement, and fostering collaborative opportunities. Nevertheless, the incorporation of technology in educational settings presents other obstacles, including the necessity for adequate teacher preparation, the restricted availability of technological resources, and the possibility of diverting students' attention.
The study incorporates enlightening case studies from a variety of schools, showcasing the successful integration of mapping through the CONNECT project, which encompasses a range of educational settings from special education to experimental and model high schools. These instances demonstrate the potential of mapping to stimulate student-centered learning, foster problem-solving skills, and promote critical thinking by tackling real-world situations via the lens of spatial thinking.
In summary, this article highlights the significant importance of geospatial technology while recognizing inherent constraints and challenges. It is imperative to prioritize ongoing teacher assistance, promote a harmonious integration of technology, and ensure equal opportunities for all students. Through the use and integration of new technologies, students have the opportunity to develop and acquire essential skills that will be vital in a future society that largely depends on digital tools.

Keywords
Geospatial technologies, open schools, maps, problem-solving, spatial thinking, educational resources, future skills.

1. Introduction

Geospatial technologies, encompassing mapping and spatial analysis tools, have gained significant prominence in educational settings. GIS is listed among the 25 most important technological innovations that influenced the development of humanity in the 20th century [10]. The utilization of visual representation in education is a potent instrument that enables students to graphically depict concepts, ideas, and relationships, so facilitating their comprehension and retention of information. The integration

of active learning techniques enhances students' engagement in the learning process, resulting in enhanced levels of comprehension.

Open education, which is distinguished by its adaptable and non-conventional learning frameworks, has observed the incorporation of these technologies due to their provision of a diverse range of advantages for both students and educators; while processing the stages CARE – KNOW-DO. Nevertheless, the process of integrating this educational approach is not devoid of its own unique set of obstacles, encompassing issues such as the requirement for comprehensive teacher preparation and the imperative need to guarantee fair and impartial accessibility for every student. Open schooling was introduced mostly with regards to science education and public engagement; there was a strong collaboration between academic/research members (universities, museums and research centers), non-academic /research members (schools and local communities) and teaching stuff [12]. Open schooling has a lot of dimensions and the most known indictors for monitoring are the following ones: science education, public engagement, open access, gender equality, ethics, governance [8]. Collaboration and communication are key components of this process, facilitating the creation of concept maps, mind maps, and the utilization of advanced technologies such as GEOspatial Artificial Intelligence (GEOAI) to enhance comprehension of spatial thinking, data analysis, and interactive visualization. Consequently, these approaches contribute to the cultivation of a comprehensive and all-encompassing learning experience. Open learning is all about removing “unnecessary barriers” to learning and about an opening of learning opportunities by adopting a flexible approach to key dimensions like time, place, pace, enrolment, accreditation, etc [2]. Teachers need to offer opportunities for their students to critically analyse maps as part of powerful geography instruction in order to help them become well-informed and civic-minded citizens [6]. When school’s projects meet the real needs of the community; for which leaders, teachers, students and the local community share responsibility, over which they share authority and from which they all benefit through [11].

2. Advantages of Mapping in Open School Education

There are many advantages of using geosciences in open schooling. As Kerski mentions "the power of a GIS is that it allows us to ask questions of data"[4]. Students using this inquiry approach form research questions, develop a methodology, gather and analyze data, and draw conclusions, but there are much more benefits as mentioned at the Table 1 [4].

Table 1. Benefits to GIS implementation

Benefit to GIS Implementation	Degree of Benefit						
			None		Some		Very Much
	Φ	σ	1	2	3	4	5
Helps teach national, state, or district standards.	3.05	1.35			B		
Enhances Learning.	3.97	1.07				B	
Provides exploratory tool for data analysis.	4.06	1.17				B	
Provides employment skills.	3.32	1.34			B		
Offers team learning environment.	3.58	1.25			B		
Provides real-world relevance to subject.	4.14	1.13				B	
Provides integration of different subjects.	3.72	1.17			B		
Provides opportunities to partner with community.	3.46	1.41			B		
Enhances motivation and student interest.	3.95	1.13				B	

2.1. Augmented Cognitive Processes and Analytical Abilities

The utilization of mapping techniques in education fosters the development of critical thinking skills and the ability to interpret geographical data among students. Students acquire the ability to analyse maps, recognize recurring patterns, and derive logical inferences, so refining their aptitude for problem-solving. Furthermore, they cultivate technological and digital skills. Through the exploration of geographical information, students are able to cultivate a more profound comprehension of intricate real-world matters.

2.2. Facilitation of Interdisciplinary Learning

Geospatial technologies serve as a means to foster interdisciplinary learning by establishing connections between many academic disciplines, including geography, mathematics, and science. Mapping projects provide students with the opportunity to delve into a diverse array of subjects, so promoting a comprehension of interrelated ideas. Contribute to a high-quality geography curriculum centred on the development of powerful knowledge [14]. These standards specifically advocate for the use of "problem-solving" geospatial technologies such as geographical information systems (GIS), global positioning system (GPS), and remote sensing as teaching and learning tools to create meaningful, authentic, and engaging social studies lessons [1]. Geographical research justifies, there are three rationalities that deliver GIS to enter into education, namely: 1) educational justification, supporting geography and environmental education teaching and learning; 2) Justification of the workplace: GIS is an important tool for knowledge workers in the 21st century; and 3) Justification based on place: GIS is an ideal tool for use in studying geographical problems on various scales [9]. Research also agrees that the implementation of GIS in education throughout the world has been developed in two main lines, namely, "teaching about GIS" and "teaching with GIS" [9]. The first is related to teaching GIS as the main subject and the other as a tool that can be useful in any of the subjects of the open school curriculum. The interdisciplinary learning is an efficient way to bring students' best practice and to create actions.

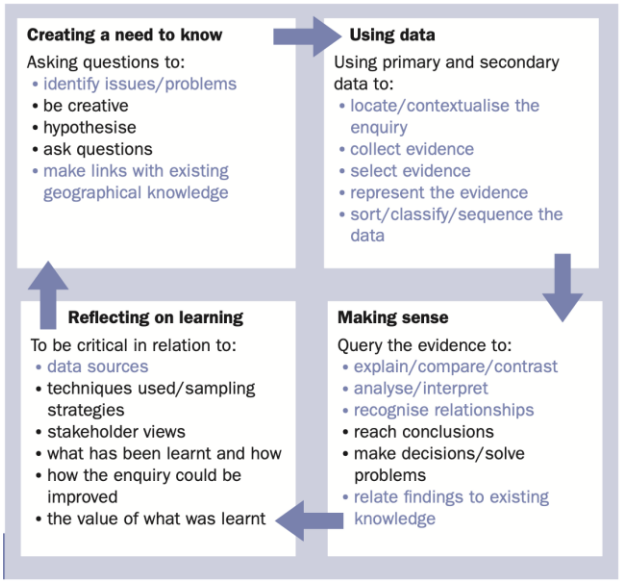
2.3. Enhanced Student Engagement

Engagement poses a frequently encountered obstacle in the realm of education; yet, the implementation of mapping techniques presents a potential remedy. GIS is also a powerful technology for geography teachers at the pre-college level; with this new tool, students can engage in serious inquiry about issues of local and global significance using authentic data [5]. GIS is defined as an instructional tool that facilitates students' engagement in inquiry and their understanding of geography and improves their skills in geographical analysis and reasoning [10]. The utilization of interactive maps and data visualization tools has the ability to attract the attention of students, hence enhancing the engagement level during lessons and fostering a sense of curiosity towards discovery. As students learned more about local community events, people, and historical forces, they became increasingly engaged with the material and enthusiastic about making connections to larger issues and processes [7]. Student involvement is obvious to any type of school that GIS projects are implemented (model high schools, experimental schools or in special education schools).

2.4. Promotion of Collaborative Efforts

Mapping projects frequently entail the participation of multiple individuals, thereby fostering a culture of collaboration among students. Individuals acquire the skills necessary to engage in successful communication, exchange ideas, and collaboratively construct complete maps, so equipping themselves for future pursuits that need joint effort. Using GIS alone does not guarantee better geographical learning, but it has the potential to become an influential tool when combined with powerful pedagogies and the role of the geography teacher is crucial in making this link [14]. In interactive teaching the instructor elaborates on students' comments and expands their thinking through fostering conversation about a particular topic [7]. Finally, it allows young people the space to imagine themselves as members of an ongoing community [7].

Figure 1. The enquiry process in geography (items shown in blue could be supported using GIS)



It is also helpful in understanding how they learn critical thinking about geographies and histories over time and in concert with others, including both their peers and their teachers [15].

3. Challenges of incorporating mapping in open school education

Continual Professional development for educators and provision of assistance

Teachers have a crucial and indispensable role in effectively using mapping technologies into educational settings. In order to ensure effective implementation in the classroom, it is imperative that educators get ongoing training to be abreast of the most current tools and practices. The integration of GIS into the teaching of geography is complicated by many factors highlighted in numerous studies and often requires a great deal of personal involvement from the teacher [10]. This is because most teachers have not had a formal education in GIS [10]. In any case, the latest trends in GIS are web-based GIS applications; which are really easy to be used and to be familiarized. Story Maps are easy to create and use, and they do not require users to have special knowledge of computer programming [1].

Restricted availability of technological resources

Not all educational institutions have access to technological resources. The difficulty of ensuring equitable access to geospatial technology for all students, irrespective of their socio-economic status, persists. Furthermore, there are more and more OpenSource or freely available GIS programs and GIS databases or web GIS services on smartphones and tablets, which has reduced the occurrence of software and technical problems for geography teachers [10]. Story Maps are Esri's Web-based GIS platform, ArcGIS Online; which combine interactive maps with stories to tell spatial narratives and digital stories [1]. Story Maps use geography to organize and present information [1]. To tell the story of a place, users create maps by linking "interactive maps with rich content text, photos, video, and audio" to build an environment that actively engages users [1].

3.3. The Perils of Electronic Distractions

In the contemporary era of technology, the presence of electronic distractions has the potential to hinder the process of acquiring knowledge and skills. Educators require effective methodologies to manage the various distractions that may arise while simultaneously leveraging the advantages offered by mapping technologies. For example, during CONNECT maps scenarios have been implemented successfully in open schooling. A scenario may depend on several dimensions which describe different learning situations: the learning domain (course topic), the learner (his know-how and knowledge levels), the tutor/teacher, the learning and tutoring activities (their typology, organization and coordination), the

activity distribution among learners, teachers and computers, the learning "procedures" according to a particular school/institution/ university and the didactical / pedagogical environment [3]. In other words, dimensions are closely related: changing one dimension leads to the change of others [3].

3.4. The obstacles faced by students

Within the educational setting, students frequently face a multitude of obstacles while engaging with the concepts of mapping and spatial learning. One such challenge pertains to spatial cognition, which necessitates the capacity to construct and comprehend the interconnections among entities and ideas within a spatial framework. Data interpretation is a significant challenge for students, since they are required to engage with intricate datasets and unravel their underlying importance. Collaboration might provide difficulties, as it requires the proficient utilization of communication and teamwork abilities. Time management is a frequently encountered challenge, particularly among students who must effectively allocate their time between mapping projects and other academic assignments. In addition, the effort of effectively organizing information inside maps can be perceived as challenging. For many individuals, lacking proficiency in technology might amplify these difficulties, as technical constraints and aversion to change serve as further obstacles to adopting mapping tools and processes. These limitations underscore the significance of implementing comprehensive support and educational initiatives to enable students in surmounting these barriers and effectively leveraging the advantages of mapping in their educational endeavours.

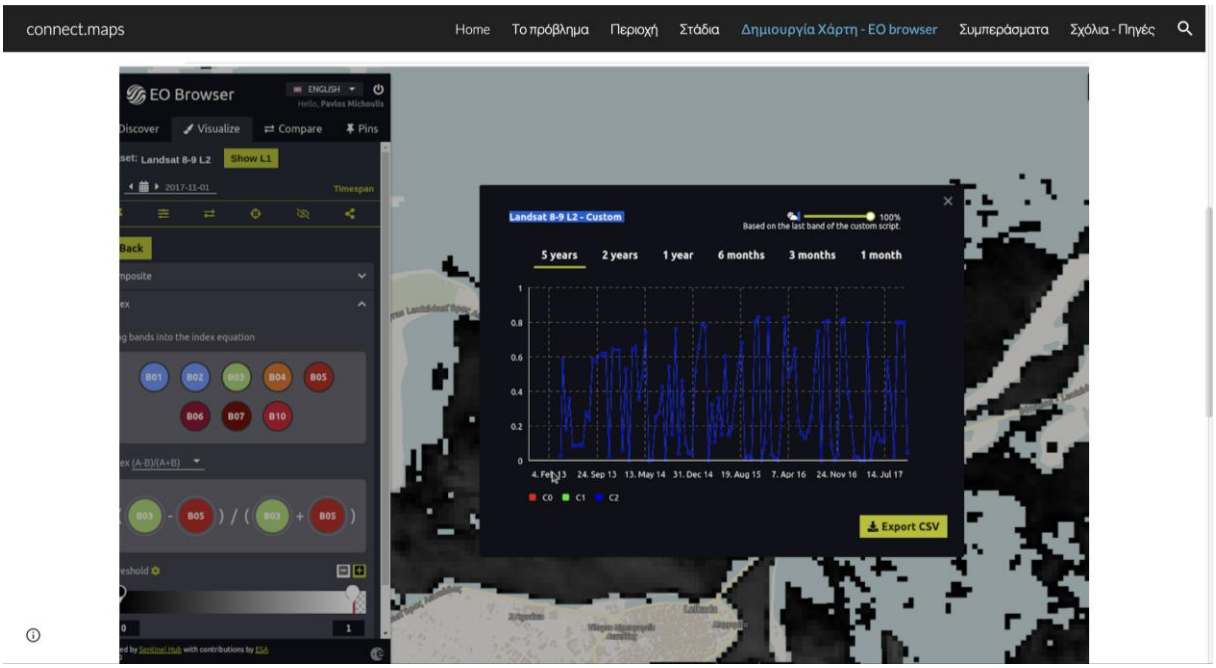
4. Case studies: Mapping Integration in Open Schools

This section presents case studies from various open schools, illustrating successful mapping integration through the CONNECT projects. Some of the below case studies encompass different types of open schools, including special education institutions, experimental high schools, and model high schools. They showcase how mapping can foster student-centered learning, problem-solving, critical thinking, and real-world issue resolution.

1st Professional High School of Lefkada

The first Professional High school of Lefkada combined different projects of CONNECT in order to investigate climate change and shoreline erosion by using the technology of GIS (QGIS) as a case study at the island of Lefkada, Greece. Their final conclusions were continuous monitoring of the phenomenon using satellite images and drones in order to predict the evolution of the phenomenon in time [13], Figure 2.

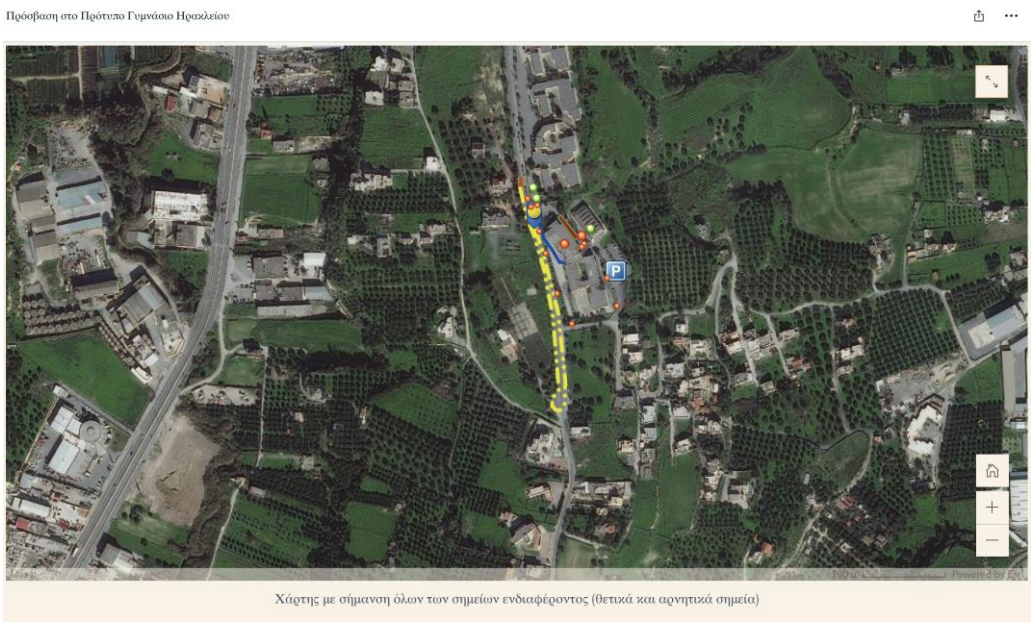
Figure 2. Landsat data analysis



4.2. The model high school of Heraklion

The model high school of Heraklion used a web-based GIS technology (Story Maps), the CONNECT procedures of CARE – KNOW – DO in order to visualize their school's accessibility. They investigated if anything more is needed, their school's benefits and challenges. Students find out the positive and negative spots around their school and fixed a relevant story map in order to inform and motivate locals and all members of school community (Figure 3) [16]. They concluded that it will be necessary to implement modifications within the school premises to ensure accessibility for those using wheelchairs, enabling them to navigate between different levels of the building. Further changes also with an inclusion of a ramp at the east entrance of the educational institution, together with the construction of a walkway encircling the premises. So the educational institution currently lacks the necessary infrastructure to accommodate individuals with special needs, necessitating the implementation of appropriate interventions.

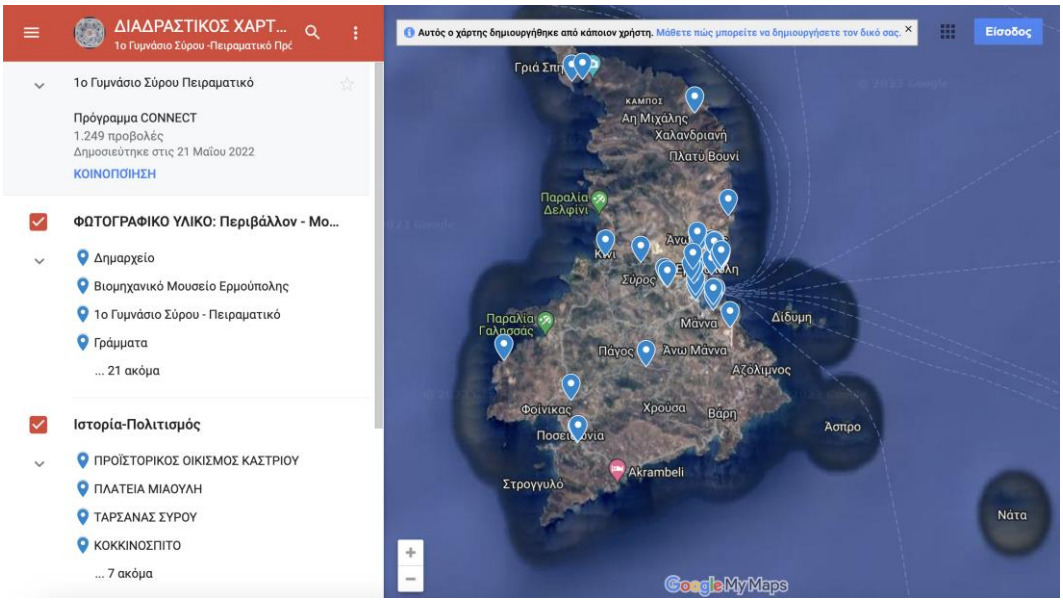
Figure 3. Positive and negative spots around the school



4.3. 1st Syros High School – Experimental

The 1st Syros High School – Experimental conducted an interactive map by utilizing Google Maps in order to create an alternative map for visitors of their island. They generated different proposals, assessed and optimized them, and collected additional data using drones. The suggested plan is depicted in Figure 4. [17].

Figure 4. Interactive map of Syros



All mentioned case studies demonstrate the potential of mapping to facilitate student-centered learning, promote problem-solving skills, encourage critical thinking, and enable the resolution of real-world issues. The CONNECT project provided numerous schools in Greece with the possibility to create open schooling scenarios through the utilization of geosciences technology.

5. Conclusions

In conclusion, it is evident that geospatial technologies play a significant role in influencing the development of open schooling. These tools possess the capacity to fundamentally transform the methods by which students acquire knowledge and teachers deliver instruction. The significance of educators in facilitating the effective incorporation of geospatial tools within educational settings cannot be underestimated. By means of their leadership and steadfast dedication to continuous professional development, educators have the ability to unleash the complete capabilities of modern technologies, thereby cultivating not just fundamental digital proficiencies but also promoting spatial cognition, data literacy, critical reasoning, and collaborative aptitudes inside their students.

Open schools are at the forefront of adopting novel ways in the quickly expanding educational ecosystem. Geospatial technologies provide novel insights, enhanced comprehension, and a means to provide students with essential skills necessary for their future roles as adults. The incorporation of geospatial technologies, namely mapping, into open school instruction has substantial implications. Nevertheless, it is crucial to recognize and address the challenges that are intrinsically associated with this methodology. This study emphasizes the importance of continuous professional development for educators, guaranteeing equitable access to technology, and a commitment to advancing and prioritizing the integration of geospatial technologies. Educational institutions that remain accessible to students possess the capacity to provide them with the essential competencies required in an increasingly technology-driven and spatially-oriented world. As we progress, it is imperative to uphold and advocate for the integration of geospatial technologies in education, acknowledging their capacity to not only equip students for an increasingly digital era but also to cultivate a comprehensive skill set that will be advantageous in a dynamic global landscape. Collectively, it is within our capacity to guarantee the preservation of open schooling as a symbol of pioneering advancements and exceptional standards in the field of education.

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Is all waste rubbish?

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Abstract. Amongst the severe environmental issues faced by modern societies, one of the more pressing ones is the management of the vast volumes of waste produced. The need to connect the school community with society gave us the incentive to create the science project "**Is all waste rubbish**", whose focus was to increase students' awareness in relation to current environmental issues in addition to their active participation as citizens of tomorrow. During the project the students were given the opportunity to work on a 'real word' problem i.e., the appropriate waste management of both solid and liquid waste and the need for a circular economy, whilst moving away from the rigid boundaries of their school environment and traditional teaching methods. The participants were able to involve their whole families and disseminate their findings with pupils in their school and other local schools.

Introduction

One of the today's societies predicaments is the management of the vast waste volumes they produce. The greatness of the issue is due to several causes starting from the big increase in size and concentration of the human population all the way to the consumer habits formed during the later years through the traditional growth model of linear economy which deals with waste as sources of water and soil pollution. Specifically, current forecasts put the size of Earth's population to approximately 9.5 billion by 2050, which in turn will increase the global demand for resources, leading to global economies demanding thrice the number of resources used today to fulfil their needs. The result would be a rapid increase of the carbon footprint due to an increase of CO_2 emissions. The only way to counteract it is reusing natural resources, the adoption of circular economy and the abandonment of the previous outdated and costly linear economy mode [1]. Circular economy contributes to society's benefit through the management of resources, waste, and the natural capital [2]. It is considered to be an answer hailing from the future, trying to achieve the ideal economy, wherein nothing goes to waste, and everything is reused. This new model requires new methods of collection, production, and consumption and most importantly it demands the active participation of all the economic operators. In societies plagued by the financial crisis, circular economy not only offers environmental benefits but also the opportunity for sustainable growth and reduction of social and economic inequalities whilst all the while respecting the environment [3].

Through the aid of CONNECT for open schooling, within the action "Science with and for Society" (SwafS) of the EU framework programme for research and innovation "HORIZON 2020" the Junior High School of Nea Alikarnassos was given the opportunity to work on the science- action project " **Is all waste rubbish?** ". Through working on the project students were given the opportunity to study circular economy and appropriate ways for both solid and liquid waste management. 30

students from the 3rd year of Junior High school took part in the project along with their family members and several scientists, such as Environmental Chemists, Chemical Engineers, Mechanical Engineers and Biologists. The aim of the teachers in charge of delivering the science project was the education and raising awareness in the students in relation to environmental issues, the main one being the management of the vast volumes of waste produced every day. Throughout the duration of the project (October 20202- April 2023) students were invited to identify issues and suggest solutions, interact with specialists in the field as well as use their own initiative and take action to educate the rest of their school community about circular economy and the proper management of waste. This innovative science-action program formed part of the curriculum topics of chemical pollution and waste management in the Chemistry and Biology 3rd year lessons. The didactical approaches used were: the discovery teaching method which introduces scientific research as part of the act of schooling, the experiential learning method, cooperative teaching, and the problem solving method [4]. The students were able to develop their skills in question editing, data analysis, evidence discussion, claim discussion, drawing conclusions and the creation of group projects.

Timeline

The project comprised of 3 distinct phases namely the CARE phase, the KNOW phase and the Do phase wherein the students initially CARE about the issue, then want to KNOW more about the issue and finally the want to DO something about the issue so they can influence the world around them and build their capacities. [5].

CARE Phase: At first the teachers heading this project presented the scenario the project was based on to the students taking part. Then the students and teacher brainstormed their ideas about chemical pollution and waste management. The students noted the ways they manage the waste their houses generate, the posed their own questions and got involved in the framework of research-based learning related to chemical pollution of soil and water and the appropriate waste management processes. Afterwards, the students were invited to express all their ideas relating to the subject and it was also requested of them to spend time at home discussing with their families firstly about chemical pollution and its effects on the environment and secondly to identify the reasons they choose to use plastic products in their daily life (properties identification). During the next meeting the teachers referred to the circular economy following a video they were shown, and they were asked to have discussions with their family about the circular economy and the importance of recycling. Finally, the students were asked to identify recycling points in the vicinity of their houses.

KNOW Phase: The students were taught about chemical pollution by their teachers with the help of their school handbooks, scholarly articles, educational videos, and presentations by the teachers heading this project. Specifically, the students were taught about the environmental issues created by the accumulation of solid and liquid waste which then led to the chemical pollution of the soil and water as well as the role of decomposers in the food chain and the geochemical cycles. (carbon cycle, nitrogen cycle). Afterwards, the students were asked to take home a work sheet and use it to identify the amount of waste generated by their household. In the following two tables we present the volumes of general waste and plastic waste generated by students and how they compare to the amounts produced by the general population of Greece and Europe respectively. Data were drawn from WWF Greece (WWF Greece: Guide for the reduction and recycling of plastics-ertnews.gr)

Table 1. Comparison of plastic waste by weight generated by students and the general Greek and European population.

Waste/Day	Kg/person
Greece	1.4[a]
Europe	1.36[a]
Students	0.9

[a] According to WWF Greece

Table 2. Comparison of plastic waste by weight generated by students and the general Greek population.

Plastic Waste/Day	g/person
Greece	190[a]
Students	164

[a] According to WWF Greece

During their next meeting the students were taught about polymer – plastics, how they are produced, their advantages and disadvantages and the issues around the fact that they do not decompose in nature. The teachers made use of their school handbooks, scholarly articles, educational videos, and presentations to cover the above topics. For the needs of the project and to better coordinate the work of the team we created an online lesson in e-class titled "**Is all waste rubbish?" (**Electronic school class (e-class) | Is all waste rubbish?... (sch.gr)) which included work sheets and useful websites that the students could utilise to further study waste management. Moreover, all members of the team were given the opportunity to pose their questions, make remarks and share their ideas throughout the project. Students then studied different types of plastic packaging and learned how to identify the polymer they were made of using the special identification symbol present on them. Following that, students were asked, using different types of plastic products they could find in their households, to collect any relevant information about the different types of plastic and the time it takes for each of them to decompose in nature. Lastly, a discussion was held about the results of their projects where their main conclusion was the importance of the circular economy and the need to avoid the linear economy.

During the KNOW phase the scientists that taught the students about the environmental issues of scenario of the project played an integral part. The students first met a scientist during their visit to the CRETAquarium "Thalassokosmos". They watched the 2-hour scientific programme "Exploring a marine threat" which allowed them to study the marine pollution caused by plastics and micro plastics. They interacted with a marine biologist employed by HCMR (Hellenic centre for Marine Research) who presented them with data about marine pollution. The students learned how to identify plastic packaging, how to separate microplastics from the sand using a stereoscope and finally calculated the percentage composition of microplastics in a sand sample from a nearby beach. The scientist also highlighted the effects of marine chemical pollution to the different ecosystems and marine organisms and explained how the phenomenon of bioaccumulation poses a major threat to humans since they are the final consumer in food chains. Another meeting took place, this time with a Chemical Engineer, of the Unified Waste Management Association of Crete (also known as ESDAK), at school. The subject of the meeting was "Waste management in the context of circular economy", the students were presented with the full array of the different waste management programmes ESDAK is implementing, based on EU guidance, all aiming at the reduction of Crete's environmental footprint. The students were introduced to different waste management projects and innovative actions for their management, such us the programme LIFE F4F (FOOD for FEED) which aims to utilise the organic waste generated from hotels for the preparation of animal feed, the pilot programme A2UFOOD for the production of bio-plastics from organic residue and the autonomous robotic system for recycling. Additionally, they learned about new initiatives that will be introduced shortly in the city such us recycling spots, recycling corners, and compensatory recycling houses. The 3rd meeting was with a Mechanical Engineer of the Public Water Supply and Sewerage Company of Heraklion (DEWAH) and its subject was Heraklion's wastewater treatment. The students visited the biological wastewater treatment plant in Finikia. They learned that part of the treated wastewater is used for the irrigation of the surrounding

agricultural areas and the remainder is disposed in the sea without any risks to the marine environment. Moreover, biogas generators are used to harness the methane generated by the sewage treatment to cover the majority of the energy needs of the plant. On the same day, they also visited the production unit of the pilot program for the production of bio-plastic from organic residue A2UFOOD.

DO phase: As part of their actions following their visit to the Crete Aquarium, the students spend some time clearing all accumulated waste out of the neighbouring beach. Using some of the recyclable materials they collected, they created handicrafts inspired by the threat plastics pose to sea turtles. Following an information session by one of the scientists working for the Unified Waste Management Association of Crete (ESDAK), they created a recycling corner at their school (Figure 1) and held their own information sessions for their fellow students. They collected photos, articles and weblinks about the circular economy and the actions Greece takes with regards to it and how it compares to the rest of Europe. After that they uploaded everything to the online magazine "OIKO-ENERGO"(schoolpress.sch.gr/oikoenergo/), which was created for the needs of the program. Using the programs Adobe Illustrator and Photoshop the students created a poster (Figure 2) to disseminate their project to the public. Additionally, they sent a letter to the mayor on the need to inform the public about recycling and the importance of circular economy. They also send some of the posters they created and suggested they were displayed around the City Hall and wherever else he deemed necessary on the occasion of World Environment Day. Lastly, the students worked on group projects which, along with the rest of their actions, were presented at CONNECT student conference.

Figure 1. Recycling corner.

Figure 2. Poster created by the students for dissemination of the project to the public.

Conclusions

During our science- action project "Is all waste rubbish?" our students learned about the circular economy and the need to recycle. They had discussions with their families and made the decision to

adapt their environmental habits, those that were not recycling before having now started doing so and those that were already actively recycling have hereon intensified their efforts. They adopted the desired stages of circular economy and became ambassadors of those matters to the rest of the students and local community. They met with experts and were given the opportunity to discuss about the chemical pollution currently affecting both water and soil as well as being able to pose their own question to the experts. This process was greeted with great enthusiasm from the children due to the opportunities they had to receive immediate answers to their questions and made them desire new knowledge outside the one offered through their textbooks. Furthermore, the students especially enjoyed their family's involvement to the learning process since they all worked together to calculate the amount of waste they were generating and then compared it to the amounts generated in the rest of Greece and Europe. Also, they calculated the amount of plastic waste they each generated and were made aware of the indiscriminate use of plastics throughout most of the products we use in our everyday life, which lead them to aim to modify their daily habits to better serve the planet and to challenge their families to behave similarly. Finally, they claimed they learned more through the projects and aids they created to disseminate their knowledge to the rest of the school and local community.

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Ecosystem stability using Open Schooling methodology

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Abstract. In this paper we are presenting a teaching proposal that we developed and applied to Greek school students in the school years 2020 to 2023. In this project we use the open-ended teaching methodology in combination with the use of digital tools. The purpose is to teach the Scientific way of thinking. Specifically, we want our Secondary Education students to get into the philosophy that we must analyze some data, get information, process them, make a hypothesis and justify with arguments whether our hypothesis is correct. Students study four different animals that we want to reintroduce into a Greek ecosystem, specifically the Gypaetus barbatus, the Eurasian lynx, the Black Francolin and the Eurasian Beaver. At the end, after weighing all the data, they will come to a conclusion. That is if a specific animal can be introduced and what special features should this reintroduction have. From the evaluation of the results of this scenario, the positive results of the proposal emerge as a deep understanding of the ecosystem processes and at the same time we see an increased interest in Sciences, apart from the fact that there is a development of student's digital and social skills. This didactic proposal can be applied as is or adapted to primary and secondary school students and also to different types of ecosystems and other animals as well.

1. Introduction

Reintroduction of animals is a strategy used to restore populations of species that are extinct or threatened with extinction. This strategy is used to help restore ecological balance and preserve biodiversity. Protecting surviving examples of rare or threatened ecosystems is vital, but recreation or restoration of degraded systems may also boost resilience and further enhance ecosystem functioning [1]. Reintroducing animals can be a challenging and complex process and requires careful planning and management. Projects and research are found the world over, with concentrations in Europe, North America, and on tropical islands [2].

Both ecological restoration and reintroduction of animals face many challenges. These challenges include the need for long-term monitoring, the potential for unwanted consequences, and the social and economic costs of efforts. Another challenge is the need for cooperation that requires the involvement of many stakeholders, such as government agencies, non-governmental organizations, local communities and landowners [3,4]. Cooperation and coordination are necessary to ensure that recovery and reintroduction efforts are successful.

On the other hand, 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 [5]. Open Schooling promotes quality education for students to develop skills for sustainable careers and the transition to digital and green

innovation in the 21st century. It expands access to learning traditionally provided through formal education systems, but can also be provided through online and distance education.

Students want to know more about real problems in order to engage the world and develop their skills, by using the CARE-KNOW-DO methodology. The CARE-KNOW-DO framework has been proposed as a basis for operationalising an Open Schooling approach, by introducing real-life issues for students to discuss and address, supported by partnerships between schools, universities, and societal representatives. This framework looks at education from a wider perspective that includes the needs for society and care for individuals [6]. It 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 [5].

2. Methodology

This teaching proposal is designed to be implemented in three teaching hours (approximately 135 minutes). Students are divided and collaborate in groups under the guidance of the teacher. The implementation can be carried out in the computer lab or in the classroom with the usage of permitted electronic devices (laptops, tablets etc.) with an internet connection.

2.1. 1st teaching hour

2.1.1. Introduction

Firstly, we introduce the students to the topic and make a connection with the previous lessons and their existing knowledge. We also announce the objectives of this lesson, which are: A) Learn about ecosystem stability and reintroduction of animals, B) Collaborate in teams and use the Scientific way of thinking and C) Acquire a responsible attitude regarding the reintroduction of animals into ecosystems.

2.1.2. CARE

In the first step, CARE, we involve the families and the STEM professionals. We present to the students the bios of the four animals recommended for reintroduction. The presentation is done by using a worksheet that has links with video, a scientific article, food web and a digital game. The students have to ask members of their family or others at home to take part in the discussion. Moreover, we can invite a STEM professional to talk about rewilding.

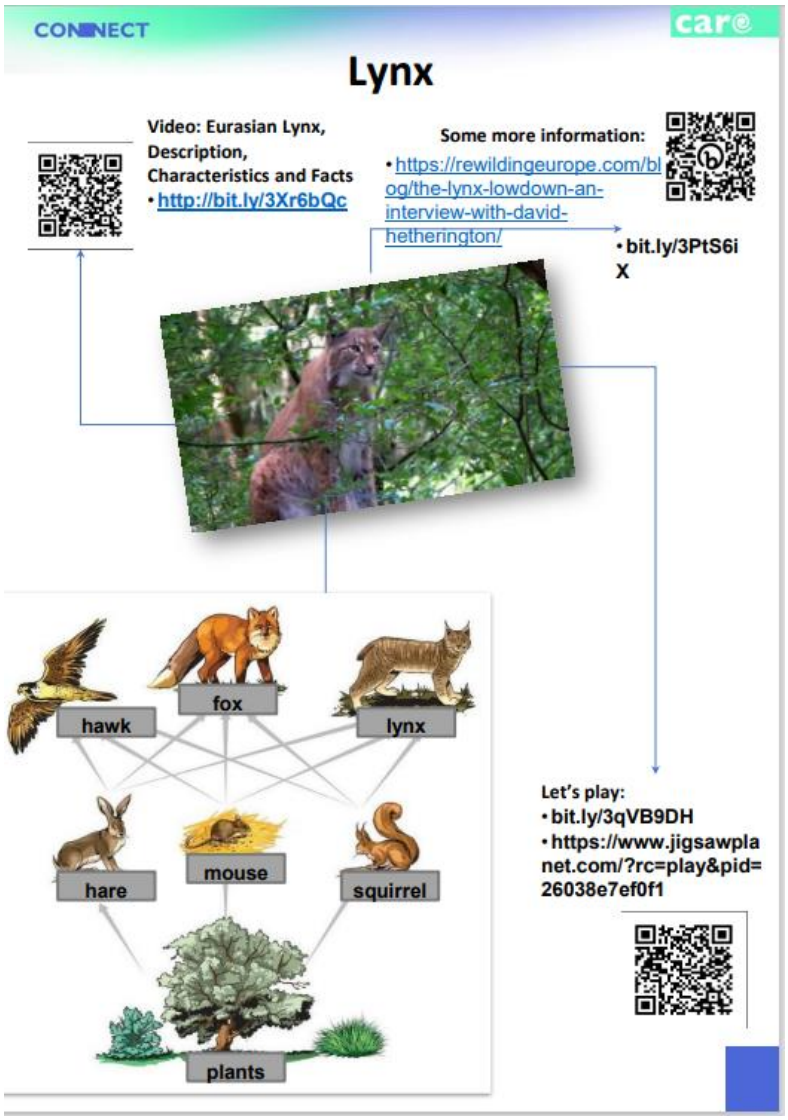

Figure 1. Worksheet for lynx

2.2. 2nd teaching hour

2.2.1. 1st activity

In this stage the students have already studied the necessary information and discussed it with their families. So, they work as a team and choose the animal that they want to be reintroduced.

Firstly, they vote in a Google Form and at the same time they watch the results.

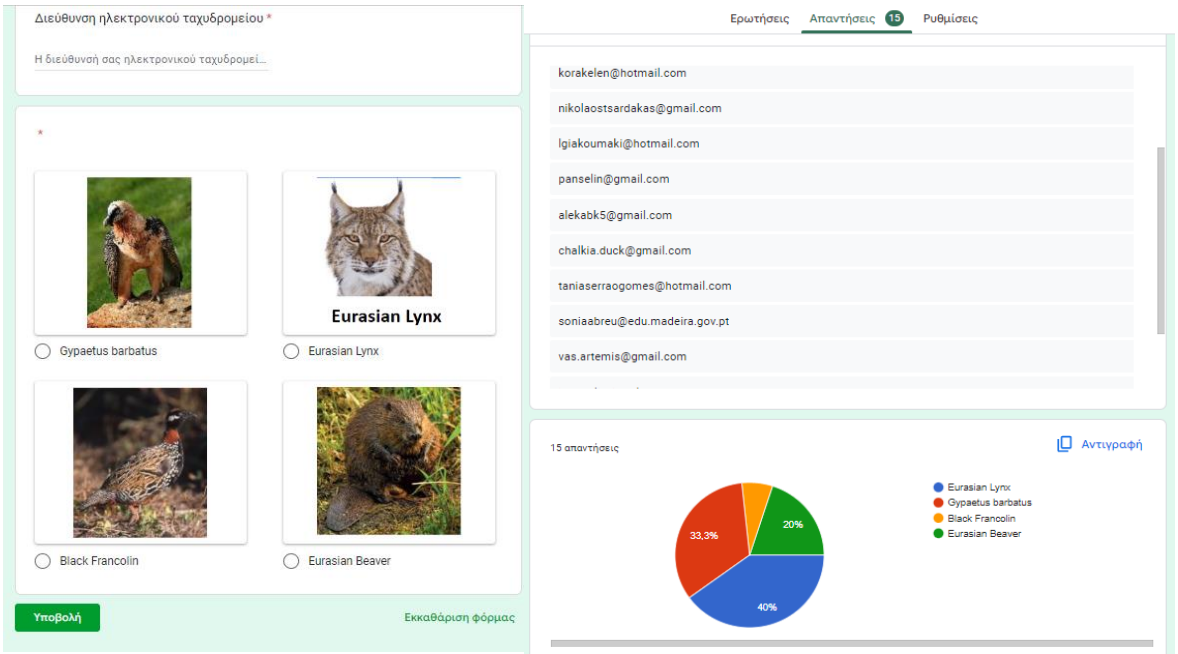

Figure 2. Voting form and results

In addition, they justify their decision in a Padlet. Next, each group will present their decision and a plenary debate follows.

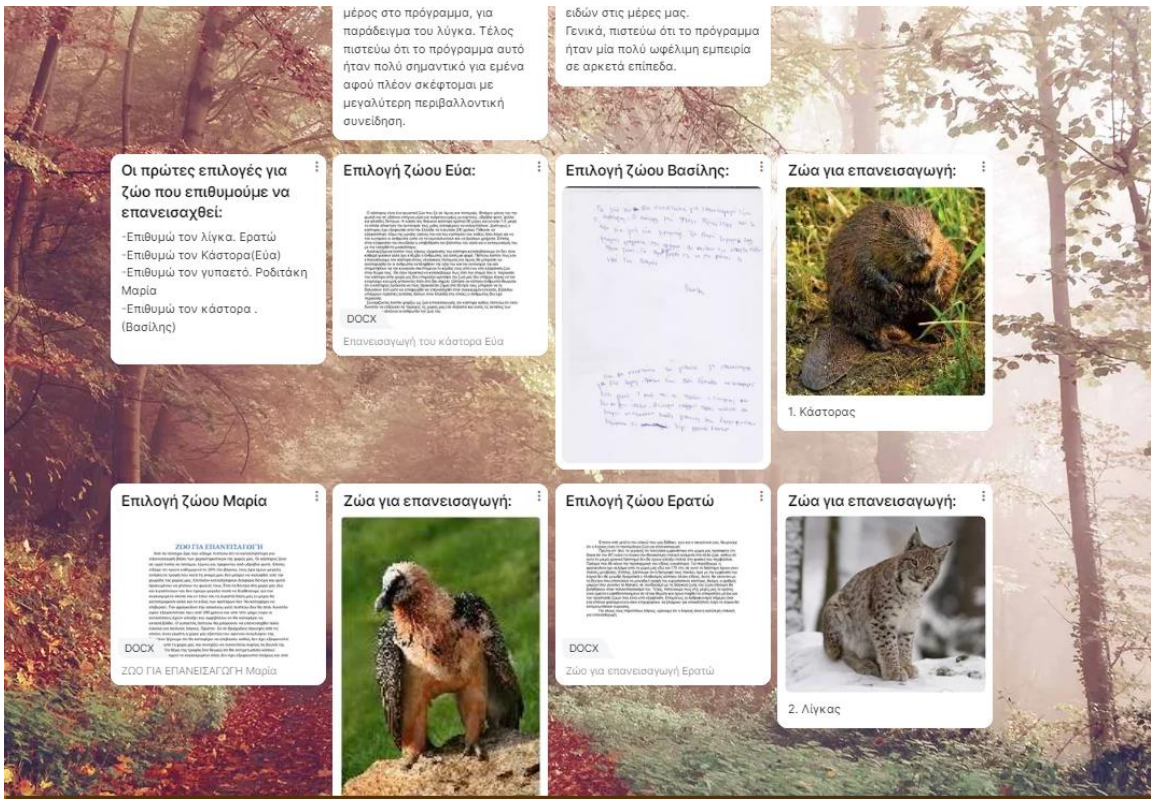

Figure 3. Padlet in which the students justify their choice

2.2.2. KNOW

There are six different stages: INTERPRET, CLASSIFY, ACTIVATE, PLAN, SOLVE, ANSWER and YOUR TURN.

In the first one, INTERPRET, the purpose is the students to make sense of the whole situation. We give each one an Apply Thinking Guide about Wolves rewilding. Also, we introduce Yellowstone Park and what happened to its wolves. We present to the class the food web and set the problem: “Can you explain the effects of reintroducing wolves?”. Moreover, we give the objectives for the activity. In the CLASSIFY stage, the goal is to decide what type of problem this is, and which key concept is needed to solve it. We discuss why they will need to use the concept of feeding relationships to solve the problem. In the ACTIVATE stage, the purpose is to bring their organized knowledge of the ideas and skills they will need into your working memory. Students complete a simple task to activate their knowledge of feeding relationships, and how to use food webs. They write down the feeding relationships shown in the food web on the Apply Thinking Guide. In the PLAN stage, the goal is to work out how they will solve the problem, step by step. We show them a plan for solving the problem. In the SOLVE stage, they use ideas and skills to work out the answer. They use slides which model how to solve the problem. In the stage ANSWER, the purpose is to write an answer, with explanation and justification if needed. In the last one, YOUR TURN stage, the purpose is for students to complete a similar problem independently and to be provided feedback.

2.2.3. Self-assessment

Students play a Kahoot game in groups. There are a series of multiple choice questions to self assess the understanding of the Ecosystem stability by using food webs.

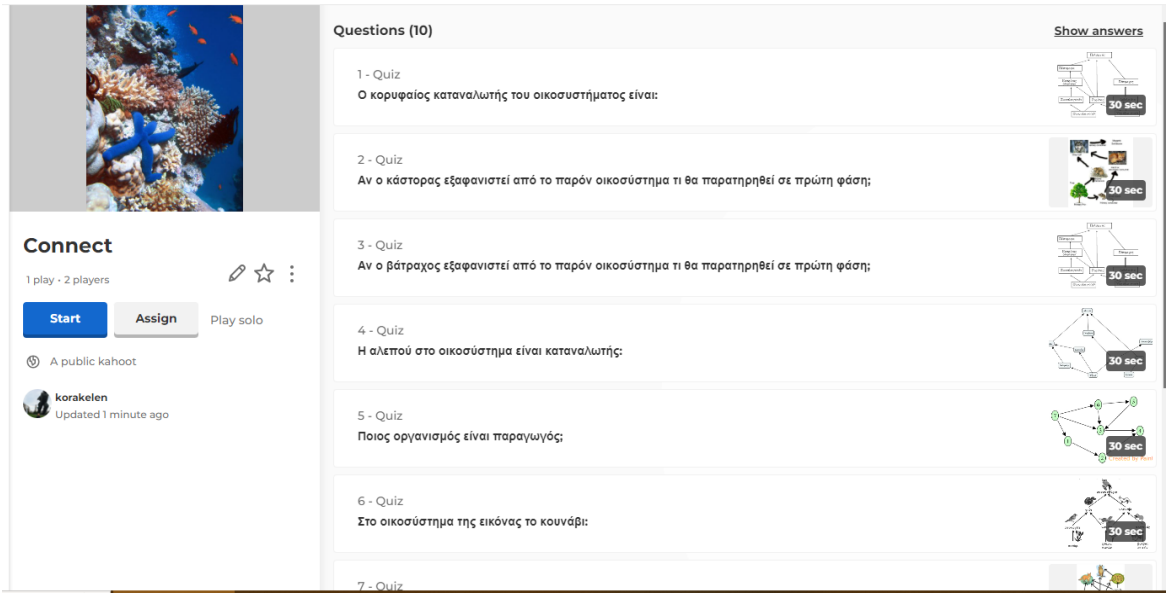

Figure 4. Self assessment

2.3. 3rd teaching hour

2.3.1. Scientific way of thinking

In this stage we remind/teach students the Scientific way of thinking, which they will use in the 2nd activity. The Scientific way of thinking (the Scientific Method) is the process of reviewing ideas using science, observations, investigational processes, and testing them to gain knowledge. The goal is to make outcomes of knowledge that may be meaningful to science. The Scientific Method is how scientists and researchers apply their scientific thinking. The Scientific way of thinking has specific steps: A) Define a Question to Investigate. As scientists conduct their research, they make observations and collect data.

B) Make Predictions. Based on their research and observations, scientists will often come up with a hypothesis. C) Collect Data. D) Analyze the Data and E) Come to Conclusions [7].

To understand even better the Scientific way of thinking, we present to the students the following example:

A) The Question: What will happen to Yellowstone National Park, when we reintroduce wolves?

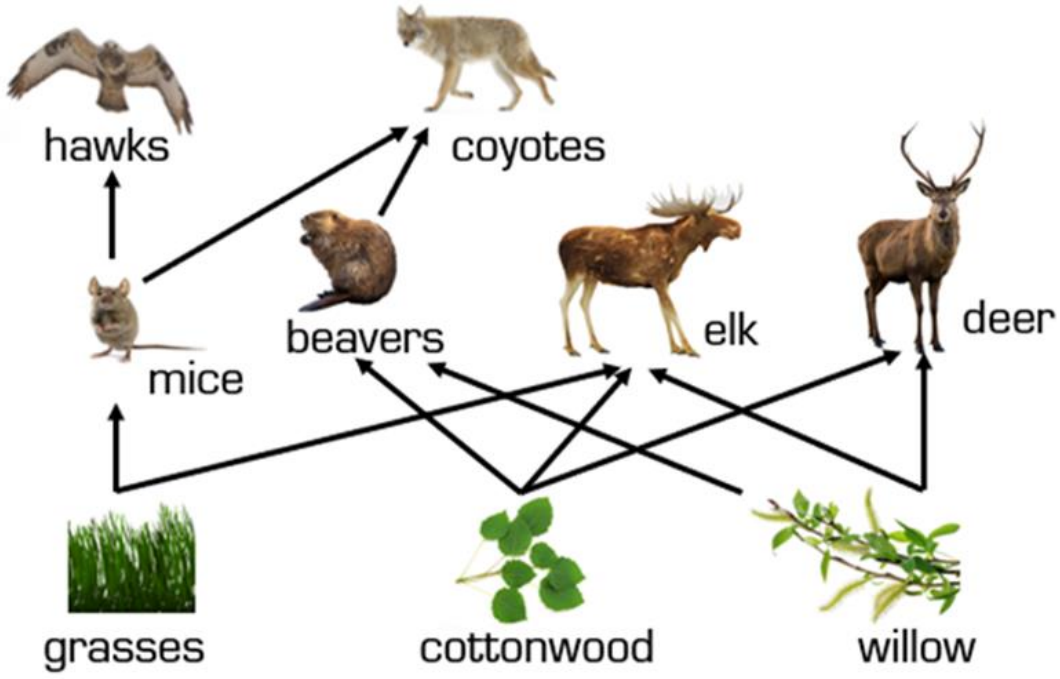

Figure 5. Example of food web before the reintroduction of wolves in Yellowstone National Park

B) Predictions: Based on the food web, scientists predict that some organisms will be reduced and some organisms will be increased.

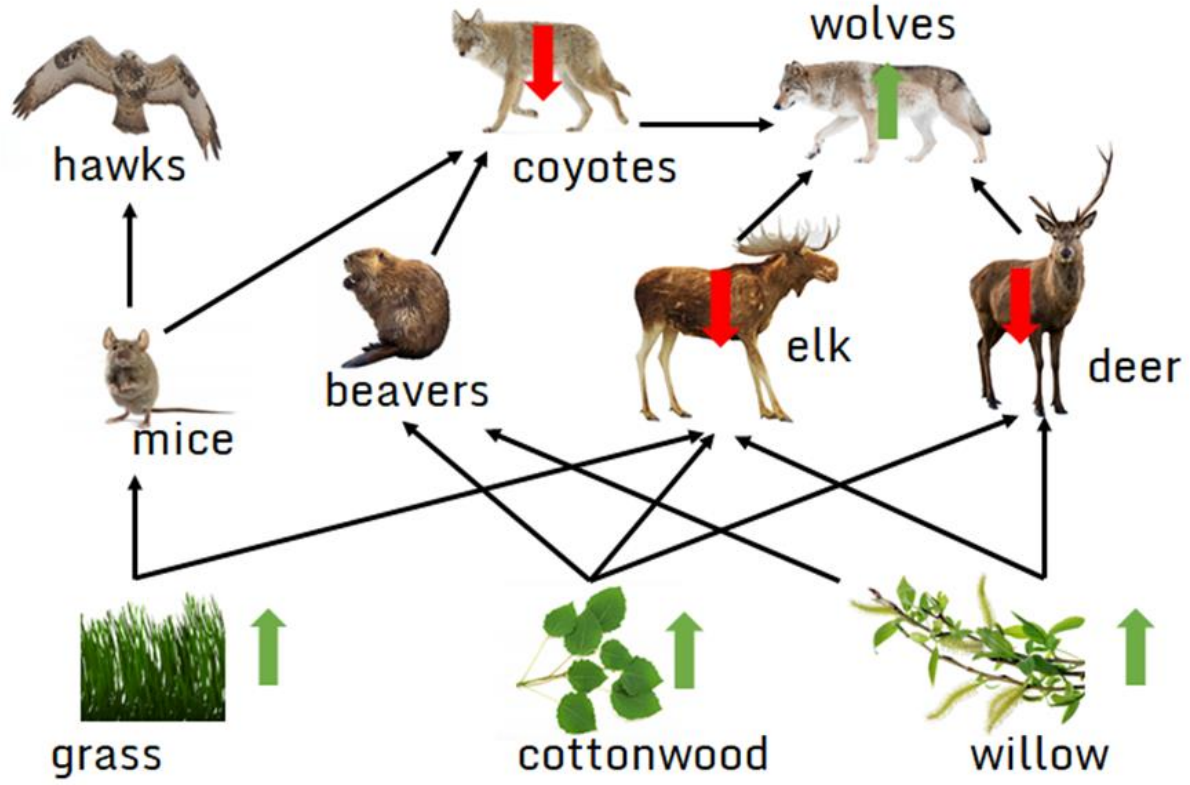

Figure 6. Example of food web after the reintroduction of wolves in Yellowstone National Park

C) Collect data: After the reintroduction of wolves, scientists collect data from Yellowstone. They observe the changes in populations from each organism and from the ecosystem overall.

D) Analyze data: Scientists analyze the data and find the correlations of these changes.

E) Come to conclusions: Scientists come to the conclusion that the reintroduction of wolves was beneficial for Yellowstone National Park. The number of deer decreased, but the number of other organisms increased and Yellowstone flourished even more [8].

2.3.2. 2nd activity

In this stage the students had already been taught the Scientific way of thinking. So, every team votes once again the contestant that wants to be reintroduced. Furthermore, they justify their decision in the Padlet. Finally, each group presents their decision and a plenary debate follows. In this stage there is additional discussion about possible changes in students' choices and the reasons that led them to change their minds.

2.3.3. DO

This is the last step, DO. Students have to plan and deliver a campaign to persuade an audience that an animal should be reintroduced. They do research and start the preparation of their presentation at home, with support from the family. At the school, they work with the Brainstorming method. The teacher gives an online concept map to fill in by using keywords to gather the positives of the rewilding of species in an ecosystem but from the point of view of ecology, agriculture, etc. of a region. The students are also provided with examples of good practices that have been done in the context of this step.

Moreover, we involve STEM professionals who act as an audience, review the quality of presentations, give feedback and be a judge.

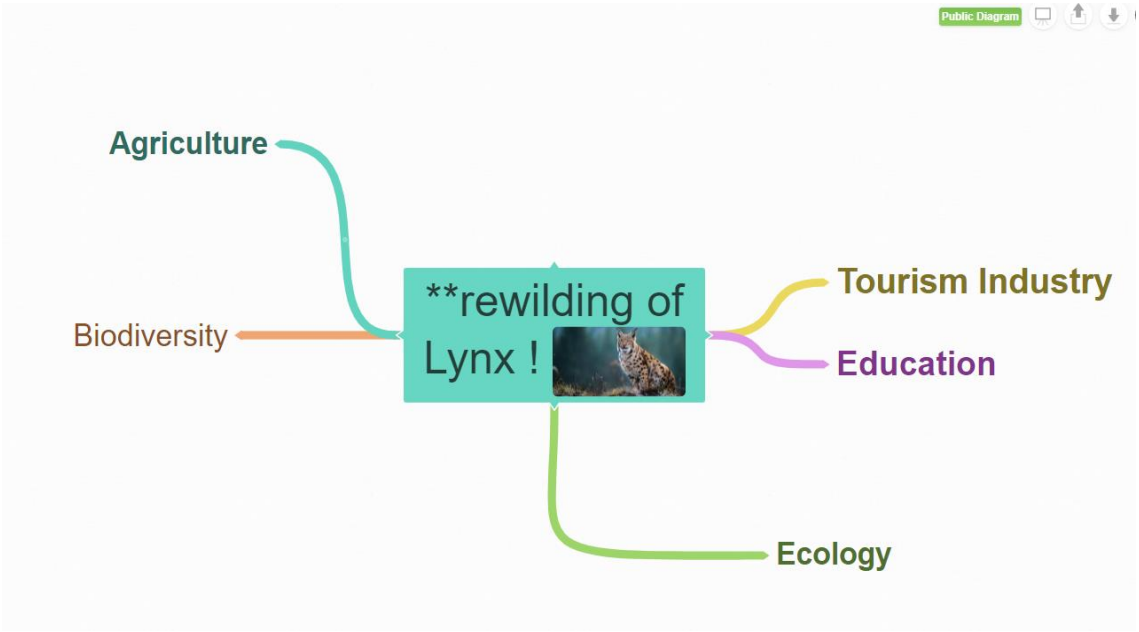

Figure 7. Online concept map

2.3.4. Evaluation

The evaluation of the students takes place in two phases of the project, in the steps KNOW and DO, by using rubrics.

a. For the evaluation in the step KNOW:

The evaluation will be carried out after the students have done the five of the six different stages: INTERPRET, CLASSIFY, ACTIVATE, PLAN, SOLVE and ANSWER. So, they have already answered the question: "Can you explain the effects of reintroducing wolves?". Moreover, they have applied their knowledge of feeding relationships and have learned the step-by-step process for solving problems by using an Apply Thinking Guide. Finally, they have to complete a similar problem independently.

Assessment rubric

Score	Level	Description	Typical student response
1	No link	One relevant idea	"I choose wolves. Wolves eat deer, so there will be less deer"
2	Partial link	>one relevant idea, simple connections	"I choose wolves. Wolves eat deer so there will be less deer and more plants."
3	Full link	At least two ideas logically connected. Use of some scientific language.	"I choose wolves. Wolves eat deer so the population of deer will decrease. Deer eat leaves, nuts, seeds, fruit and grasses so the population of plants will increase. This provides more plants for insects, finches and squirrels to eat so their population will increase"
4	Extended link	Several ideas connected with scientific reasoning. May link to other concepts. Use of accurate scientific language.	"I choose wolves. Wolves eat deer, so the population of deer will decrease. With less deer there will be more plants. With more plants, the population of the herbivores that eat plants (insects, finches and squirrels) will increase. A higher population of herbivores provides food for predators - bats, foxes and owls so their population will also increase. So, the introduction of wolves will result in the increase in population of lots of different animals at every stage of the food chain"

Figure 8. Assessment rubric for the step KNOW

For the evaluation in the step DO:

Students collect evidence for claims. We give them a sheet which describes how to plan their presentation by collecting evidence for four different claims. Next, they plan their presentation in their group and finally groups present their presentation. We use an assessment checklist.

Assessment checklist SS5

Section	Content	Group/ animal	Group/ animal	Group/ animal	Group/ animal	Group/ animal	Group/ animal
Beginning	Overview of what you will talk about						
	Information about rewilding						
Strongest claim	Stating the claim						
	Giving evidence that supports it						
	Giving reasons						
Other claim 1	Stating the claim						
	Giving evidence that supports it						
	Giving reasons						
Other claim 2	Stating the claim						
	Giving evidence that supports it						
	Giving reasons						
End	Repeating the strongest claim						
	Telling your audience what to do						
	Total for presentation (mark out of 13)						

Figure 9. Assessment rubric for the step DO

3. Results

The goal of the teaching proposal was to combine the Scientific way of thinking with an educational practice that would arouse the interest of the students. That is, we wanted students to achieve a deeper understanding of scientific research in Sciences (analyze data, get information, process them, make a hypothesis and justify with arguments whether our hypothesis is correct), but in a more enjoyable process. For this purpose, we used the open-ended teaching methodology in combination with the use of digital tools.

To evaluate the proposal in terms of the achievement of its objectives, a graded criteria scale (Rubric) was used twice. The results were very encouraging.

Particularly, in the step KNOW the majority of students were able to do a full or extended link using at least two logically connected ideas. Moreover, some of them used several ideas connected with scientific reasoning. Also, many of them used accurate scientific language and they gave links to other concepts.

Furthermore, in the step DO their presentations include all required elements as well as additional information. Namely, they gave evidence with reasons to support their claim. There was the strongest claim for rewilding an animal and a brief description for at least two other claims.

Additionally, the students voted twice for the animal that they wanted to be reintroduced into the Greek ecosystem. Through the voting we wanted to record any changes in decision making after teaching the Scientific way of thinking. The first vote was after the step CARE. The participants had studied the bio of the animals and had discussed it with their families. The second one took place after the step KNOW. They had been taught the Scientific way of thinking and the Scientific data were added to the discussion after speaking with an expert scientist. Admittedly, a remarkable change was observed in the students' decisions. While in the first vote the majority of students chose the beaver for rewilding, in the second one no one chose the particular animal. Also, they justified their view on the fact that it would not have a chance of survival as there was no suitable ecosystem, so any rewilding attempt would face many problems. On the other hand, the majority in the second vote supported the rewilding of Gypaetus.

In addition, students evaluated this scenario using the online application of Mentimeter. This evaluation aimed to record the participants' attitude (positive - negative) towards the teaching proposal. All the students evaluated the proposal very positively. Also, they have to describe their feelings about the teaching method by using one word. They wrote the words: playful, enjoyable, interesting, knowledge, funny, team work.

4. Conclusions

For the best address of the rapid and constant technological, social, and economic change in society, formal education practices should be reinforced by non-formal educational practices. The Open Schooling satisfies this need, as schools are transformed from traditional educational institutions into community partnerships and become agents of community well-being [9].

In this project we use the open-ended teaching methodology in combination with the use of digital tools. From the evaluation of this scenario, the positive results of the proposal emerge as a deep understanding of the ecosystem processes and at the same time we see an increased interest in Sciences, apart from the fact that there is a development of students' digital and social skills. Also, with the use of digital tools, the educational process becomes playful and therefore more enjoyable for the students. Moreover, the collaboration with scientists and experts increased the students' interest in future professional employment in the STEM field.

Admittedly, this teaching proposal needs to be implemented in a larger number of schools so that there is more data and we can talk with certainty about the cultivation of the Scientific way of thinking of the participating students.

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Good practices that promote respect for nature among the young

DOI: 10.5281/zenodo.10148583

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Abstract:

The "Aurel Vlaicu" Theoretical High School, a partner institution with Valahia University in Targoviste within the CONNECT Project, promotes the transition towards an ecological, healthy and sustainable lifestyle by maintaining a clean environment, taking responsibility for pollution prevention and resource management without endangering the natural balance of the planet. The young generation needs examples of good practices, because they gain motivation, openness to cooperation, communication and a positive attitude towards nature.

The realization of activities by students together with teachers, parents and other members of the community, is an effective way to consciously do ecological education through which part of the local environmental problems can be solved, with a positive impact at the macro-regional level.

Keywords: ***positive attitude towards the environment, ecological education, practical activities.***

"Aurel Vlaicu" Theoretical High School is the largest school unit in Prahova county, coordinating 6 kindergartens, 4 primary and secondary school and high school structures, spread over the entire area of Breaza. About 1600 students learn in a stimulating and collaborative environment.

The following participated in the CONNECT Project: approximately 300 students from all levels of education, 25 teachers, parents, members of the local community.

Involving students in community life through environmental projects aims to form an ecological behavior that helps to complete the personality and consciousness of future citizens.

Objectives:

1.The need to adopt an ecological behavior both in students and at the level of the society in which they live .
2.Bringing man into a position to respect the values of nature and the environment in which he lives.
3. Substantiating environmental education through the power of example.
4. Developing an active community of students who promote respect for nature.

Within the theme proposed by the CONNECT Project "Biodegradable plastics – a solution for white pollution", the following activities were carried out: popularization of the project theme, environmental questionnaire, greening, planting, and selective plastic collection campaigns, debate, research activities, products of students.

Using Google's Clasroom platform, we created a class called Connect with Science for better collaboration, we uploading materials to the classroom, viewing materials on plastic recycling and solving tasks for students (fig.1)

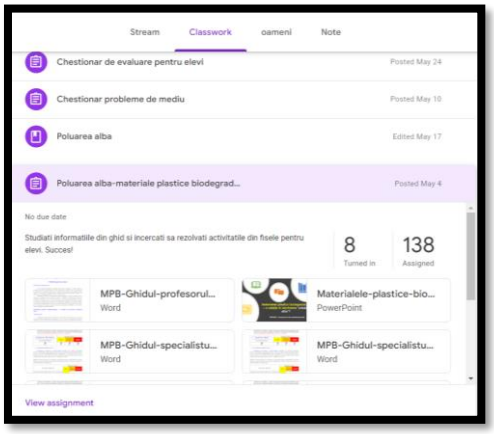

Figure 1. "Connect with Science" on Google's Clasroom platform.

In a first stage, we applied an environmental questionnaire to identify the degree of information and awareness on plastic pollution.The questionnaire was answered by six hundred and eighty-two respondents, of whom about forty-one percent represented parents or teachers, the rest being students. To the question What do you understand by protecting the environment? five hundred and eighty-six people responded to protecting nature and two hundred and sixty-seven answered cleaning. 91% of people agreed that human activities influence environmental quality. When asked what is the biggest problem facing our planet, 37% answered improper waste disposal, other thirty-seven percent answered lack of involvement in waste reduction, and twenty-five percent answered throwing packaging on the ground. We asked what is the source of information on environmental protection and 61% replied from internet, 38 % replied from TV, radio, 29% replied from extracurricular activities. At the question Who should care about protecting of environment? 83% replied every citizen, 38% local authorities, 11% believes that schools should be concerned about environmental protection. Consider efforts to reduce environmental pollution in your city to be satisfactory and effective? and 50% answered yes.We ask if a correct attitude towards the environment leads to an increase in the quality of life and 55% of respondents believe that a correct attitude towards the environment would considerably improve their quality of life.

Other activities carried out within the CONNECT Project:

- ✓ Greening activity in Constantin Brancoveanu Park-an emblematic place for the Breaza town (fig.2)

Figure 2. Greening activity in Brancoveanu park.

- ✓ Planting activity in the schoolyard (fig. 3): our students planted flowerbeds in the school yard, thus practicing their gardening skills while also contributing to the beautification of the playground.

Figure 3. Planting activity in the school yard.

✓ Arrangement of a solarium in the kindergarten yard where students can observe morphological changes that occur at different stages of plant growth(fig. 4).

Figure 4. Gardening activities in the solarium in the kindergarten yard.

✓ Selective collection of plastic for recycling. We initiated the campaign in school with the title:"*Inspire students in your school to go plastic free.*" With the help of a parent who sponsored the school with the purchase of five bins, we were able to selectively collect the plastic. Breaza City Hall then took care of transporting it to a plastic recycling company. As a result of this activity, students noticed a 12% reduction in single-use plastic packaging used in school in a week.

✓ In philosophy class, students debated the topic of environmental pollution. For example at the question Shoud developed and developing countries be subject to the same constraints in terms of pollution standards? The pro argument on this topic was that It is normal for these constraints to apply to all states because people, being consumers, through their activities pollutes the environment.The contra argument on this topic was that constraints are not strictly about implementation their micro-level (individual level) and weak states developed need financial support to be able to cope with these constraints.

✓ Also, within the CONNECT project we carried out a series of research activities. Using the lab experiment, the students obtained biodegradable plastic and used it to plant parsley seeds. After about a month after planting, the plant can be observed (fig.5).

Figure 5. Obtaining biodegradable plastic.

✓ The students made a case study with the topic Chewing gum contains plastic or not. Research has found that chewing gum contains plastic and can therefore be recycled. In England there are containers on the street in which chewing gum can be recycled, called GUM-DROP. The plastic obtained from recycled gum is called GUM-TEC and is used to make various objects.

✓ Flyers, posters, advertising spots, plastic decoration and literary creations- within these activities, the students demonstrated their creativity and developed various skills (fig. 6, 7).

Figure 6. Flyers,,White polution".

Figure 7. Plastic decoration.

The impact of this activities: incorporating skills-development into your classroom activities can stimulate students to reduce the use of plastics in their own life. Many students take the message home to their families and try to reduce plastics together.Modelling behaviours is a great way to quietly reinforce simple solutions for living plastic free.

Ecological education will reach its true goal only when the students - the citizens of tomorrow - will be convinced of the necessity of protecting nature and will become decision-making factors in the action of reconciling man with nature. Aware of the co-evolution with nature, the health of the local environment, students will understand the usefulness of these practical actions to care for and protect the environment.

Group discussions and messages collected from the target group (children, parents, teachers, members of the local community) reinforce our belief that such projects capitalize on the immense potential of children and teachers who can turn such activities into successful experiences.

Conclusion:

The activities proposed by CONNECT Project, promotes the transition towards an ecological, healthy and sustainable lifestyle by maintaining a clean environment, taking responsibility for pollution prevention and resource management without endangering the natural balance of the planet.

The young generation needs examples of good practices, because they gain

Monitoring climate change

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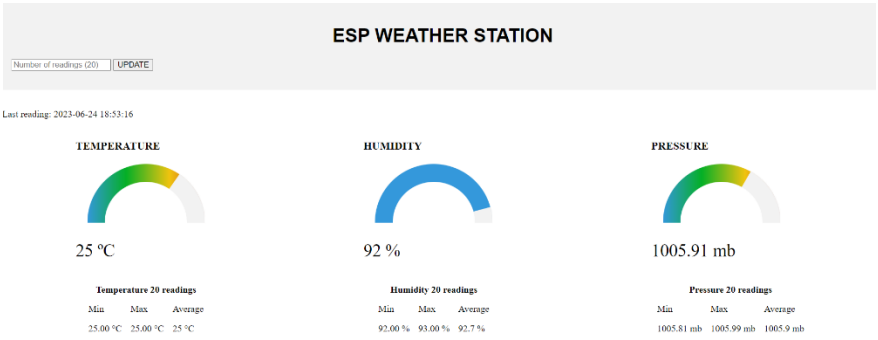
Abstract. The students studied a scenario about global warming and climate change. The purpose of the scenario was to encourage students to discover the factors that lead to global warming and climate change. The didactic approaches followed by the scenario were: the exploratory, the experimental, the collaborative and the problem solving method. The scenario followed the steps: care, learn and act. The scenario made students aware of a real problem with local, global, present and future implications

The students studied the scenario about global warming and climate change. The purpose of the scenario was to encourage students to discover the factors that lead to global warming and climate change. It is accepted that the burning of fossil fuels leads to global warming which contributes to climate change. The students worked on a real problem and tried to find solutions. The aim of the scenario was to make them environmentally oriented citizens. Climate change refers to the increase in the earth's average temperature and the rain distribution over the last 50 years. This increase is linked to the greenhouse effect and the gases present in the atmosphere such as carbon dioxide, water vapor and methane. Human activities contribute to the greenhouse effect. Climate change is nevertheless a millennia on going process with man nowdays contributing to it. Increasing earth population, deforestation, change of land use, inevitably lead to climate change. The purpose of the scenario was for the students to understand that their actions and daily habits contribute to global warming and reinforce climate change. The didactic approaches followed by the scenario were: the exploratory, the experimental, the collaborative and the problem solving method. The scenario followed the steps: care, learn and act.

In the "care" stage students' perceptions of climate change were explored.

In the "learn" stage they watched appropriate videos and studied articles about warming, weather, climate and the physical processes involved. They watched some videos together with their parents, answered quiz questions for better understanding the problem and also discussed and exchanged opinions on the specific topic. The students met with two specialist scientists who presented them the scientific problem and they discussed with them the prospects of the future.

In the "act" stage they produced material that presents the problem and proposed solutions in order to limit it. They constructed an electronic weather station which measures temperature, relative humidity, surface pressure and rain height and publishes the data on the internet.

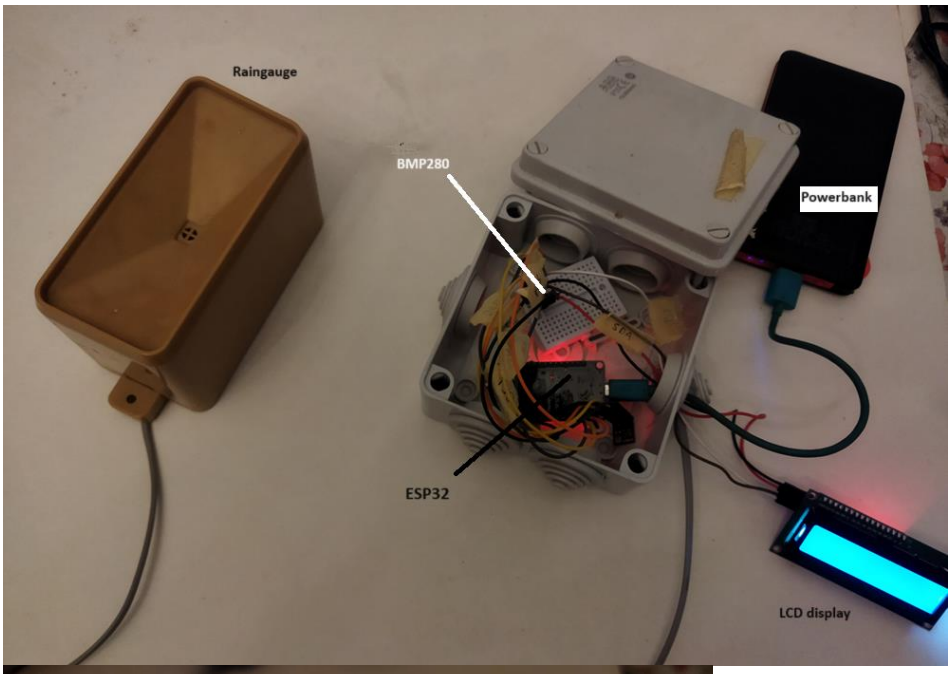


View Latest 20 Readings

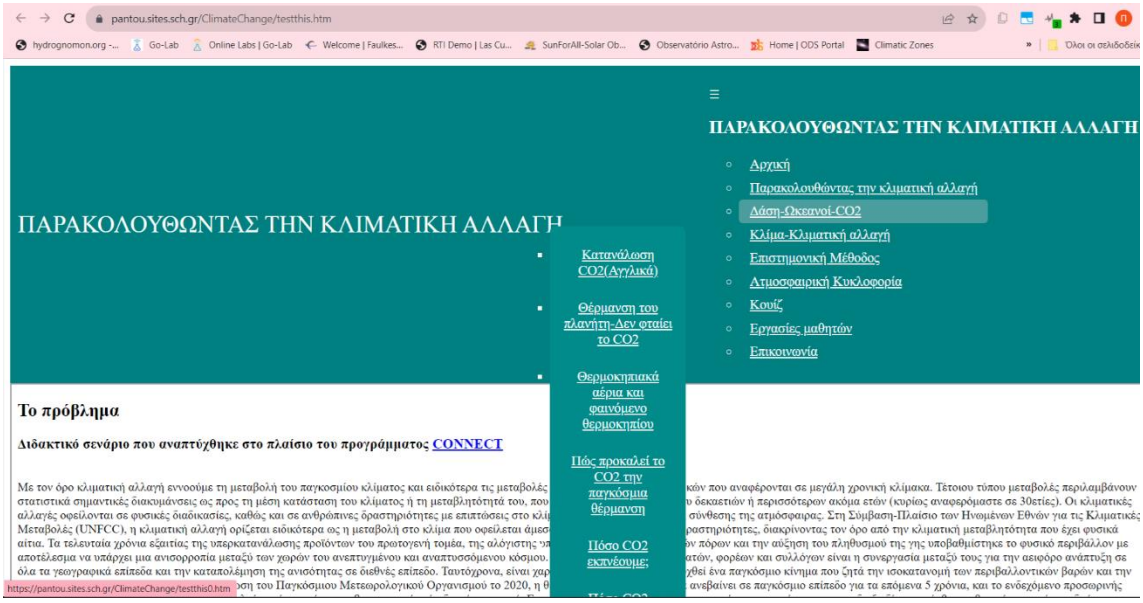
View Latest 20 Readings

ID	Sensor	Location	Value 1	Value 2	Value 3	Timestamp
13479	BMP180	home	25.00	92.00	1005.91	2023-06-24 18:53:16
13478	BMP180	home	25.00	93.00	1005.97	2023-06-24 18:53:08
13477	BMP180	home	25.00	93.00	1005.92	2023-06-24 18:53:01
13476	BMP180	home	25.00	93.00	1005.91	2023-06-24 18:52:54
13475	BMP180	home	25.00	93.00	1005.98	2023-06-24 18:52:46
13474	BMP180	home	25.00	93.00	1005.93	2023-06-24 18:52:38
13473	BMP180	home	25.00	92.00	1005.83	2023-06-24 18:52:31
13472	BMP180	home	25.00	92.00	1005.90	2023-06-24 18:52:23
13471	BMP180	home	25.00	92.00	1005.92	2023-06-24 18:52:16
13470	BMP180	home	25.00	93.00	1005.99	2023-06-24 18:52:09
13469	BMP180	home	25.00	93.00	1005.86	2023-06-24 18:52:01
13468	BMP180	home	25.00	93.00	1005.96	2023-06-24 18:51:54

The weather station consists of a ESP32 microcontroller (Arduino with wifi) a BMP280 sensor able to measure atmospheric pressure, temperature and relative humidity, a raingauge, a LCD display and a powerbank which provides the required electrical energy. The construction and the programming of the electronic weather station was quite challenging but the motivation of the pupils led to success in the construction and function of weather station.



They developed a webpage with address https://pantou.sites.sch.gr/ClimateChange/testthis.htm which is being updated and contains publications , papers and data concerning climate change.



Additionally, they developed a questionnaire to test their classmates' knowledge and perceptions on environmental and energy consumption issues. Furthermore, they prepared an article for the local newspapers and a proposal to the municipality of the city proposing how to better the transfer conditions with public transport , as well as proposals to improve the city's green spaces.
The content of this letter can be read in the following lines:

«Dear Mr. Mayor,
I am writing to you on behalf of Section B2 of the Heraklion Standard High School in order to to propose solutions to transform our city into a more sustainable, environmentally friendly city. environmentally friendly and capable of fighting climate change.
The only way to transform our city directly into an environmentally friendly city is to make it more sustainable and sustainable.
is to make changes, improvements or even modifications to existing buildings infrastructure. To begin with, one way to increase the urban greening rate is to creating rooftop gardens, starting with our municipal utility buildings. By this way, residents will be inspired by this act, which will certainly attract many residents, and apply it to their own homes or properties.
As a result, our city will have lower carbon dioxide levels, as plants absorb sufficient amounts and clean the atmosphere. In addition, one way to reduce the carbon dioxide in the atmosphere is to improve the conditions of everything concerning public transport. The majority of residents avoid using public transport because of the unreliability of its programs. This unreliability is usually due to traffic congestion, especially during peak hours, and various technical failures that may occur on the route. This frequent inconvenience causes residents to use private vehicles, which emit additional carbon dioxide. If the buses are replaced with newer buses, residents will prefer to use these means on a daily basis. Therefore, less carbon dioxide will be emitted carbon dioxide. In addition, in order to achieve our goal and fight climate change as much as possible, we need to exploit the sources of renewable energy energy sources. Firstly, it should be made compulsory to install and use solar panels in every building in the city, so that minimal energy is consumed for to heat domestic water. Next, provision should be made for the installation
solar panels in areas with high energy consumption, such as public services, utility centres, etc. Solar panels are quite undervalued and are being devalued by by many people. However, they can produce large amounts of energy and for large multi-space buildings, with the SNFCC being a key example, which during sunny days ...generates enough electricity to power all of its buildings... needs for several

hours! It is of course necessary to recycle the construction materials of photovoltaic panels and the batteries that accompany them, in order to avoid pollution from some toxic substances involved in their construction. Furthermore, a large proportion of organic waste can be reused for the benefit of the planet and the atmosphere. Composting, the creation of natural fertilizer, can replace the polluting creation of artificial fertiliser, which consumes excessive amounts of water and electricity. A side effect of this will be the cultivation of healthier and less toxic food, as vegetable fertilizers do not contain toxic substances. Also, the exploitation of renewable energy sources is vital, as it avoids using up expensive and limited energy resources, which pollute the environment when they are burnt. An issue which, of course, goes beyond the boundaries of our city, but which is very important is the reforestation and protection of forests from fires. Any forest area that burns should be immediately adopted by our city to make it safe and of course its reforestation. It is our duty to face the threats of climate change to reforest all burned forests where this has not been done.
The environment and human beings are in a critical situation and with collective we can improve it considerably. If the above steps are taken and individual effort is promoted, then our city will be able to fight climate change to its fullest extent.
Sincerely,
B2 Model High School of Heraklion»

An important aspect of the scenario was the comprehension and use of the scientific method as an approach to solve environmental problems. The scenario made students aware of a real problem with local, global, present and future implications.

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Youtube : Can you fix climate change? (https://www.youtube.com/watch?v=yiw6_JakZFc)
Website : COP26 (https://ukcop26.org)
Website : There is no climate emergency https://clintel.org/

Educational Materials to download or watch
To watch a video on you tube with Greek subtitles we must first select subtitles and then from the automatic translation option Greek
The following link contains material that can be used by the educator to understand the natural phenomena and human interventions that can cause or contribute to climate change.
https://drive.google.com/drive/folders/1LJUkgrEsXozGYidc7sLo2w6VPuERsi7P?usp=sharing
Video
1A . Very accurate recording of CO 2 emissions in Heraklion
https://www.youtube.com/watch?v=Y_nK4Afmon0
1B. Foskolos: "climate change exists, it is not due to carbon dioxide"
https://www.youtube.com/watch?v=IvuCEROEjI8 **abnormal phenomenon**
1C. The anomalous greenhouse effect
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1Z S. Kamenopoulos : The exaggerations about climate change and hydrocarbons
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https://www.youtube.com/watch?v=6aNkmXArlZk
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https://www.youtube.com/watch?v=S-nsU_DaIZE
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Links translated
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https://www.youtube.com/watch?v=JHN7PrU5ZYw

Renewable Energy Sources: An educational approach in Greek Schools

DOI:10.5281/zenodo.10149031

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Abstract. In this article we introduce the educational scenario titled "Renewable Energy Sources" which has been developed within the framework of the Connect project. We outline the implementation of this educational scenario in Greek schools and describe the pedagogical approach that students have engaged with. Furthermore, we highlight the key outcomes resulting from this implementation. Our findings strongly indicate that this scenario significantly enhances students' confidence in science. ←

1. Introduction

Over the past three years we have actively participated in the Connect project, a European project that is dedicated to open schooling and participatory science [1]. Open Schooling purpose is to establish purposeful collaborations between educational institutions and their broader communities. This approach involves engaging families, experts, and various stakeholders in partnership with teachers and students. The goal is to address relevant local challenges, and promote a global citizenship mindset. The Connect project is designed to empower educators and schools to embrace open schooling in the core of the curriculum and basic aim is to increase the science capital for each student. We decided to design an educational scenario where the main objective was to investigate the environmental advantages of utilization of renewable energy sources (RES) instead of the combustion of fossil fuels. In this study we present the three phases of the RES educational scenario and also we refer to the important elements of Connect project that is to envolve the family of the students as well as students to be guided and inspired from scientists. Among the pedagogical phases we present the android application which is developed especially for the RES educational scenario. Additionally, we show how other schools of Greece implemented this specific didactic approach. Finally we discuss the opportunities that arise for our students and what are the main advantages for them.

2. Phases of the scenario

The educational scenarios that are implemented through Connect project are developed usinsed on the pedagogical frame of the three phases: Care, Know, Do. These three phases have been proposed as a basis for an open school didactic approach [2]. The RES educational scenario is designed to be performed in the Physics class of the third grade in Greek Junior High school, in the chapter of electrical energy [3]. It deals with the real problem of the pollution of the environment arised from the energy combustion plants. Especially in the island of Crete in Greece where our students live, there are three

energy plants of this type producing about 70% of the electrical energy used [4], therefore they face the problem of pollution every day.

2.1. Care phase

In the first phase students were informed about the real problem through a video of the University of Macedonia of Greece where they could observe the journey of the electric energy and the consequences of the pollution from energy combustion plants. Then they discussed the problem with their families by completing a questionnaire. Subsequently, students engaged in a comprehensive classroom discussion. Due to the COVID restrictions students played an electronic escape room game designed by the first author. Students awareness is a very important element in this phase in order to motivate them. Students also show care about the environment and think alternative ways for energy consumption. Similtaneously students develop responsibility and ethical values that are important elements to become responsible citizens. Their families play a crucial role by recognizing that their children are dynamical individuals and that can think solutions to real and open problems of the society. Connect project not only gives the framework in the learning process but also connects family with the school. Family members support and encourage students while through collaboration give positive reinforcement and boost student's confidence.

2.2. Know phase

In the second phase students explore the real problem using the android application "Energy Consumption". This application was developed especially for the Connect project by the second author, and it is possible to download it from Google Play (figure1). Students download the application in their devices and then calculate the energy consumption with their parents and discuss their findings in the class. This activity help students to realize that they can reduce the energy consumption in their houses. Afterwards students think and discuss the questions that pose in an expert scientist. The scientist is a professor in the Hellenic Mediterranean University and is specialized in photovoltaic systems. In this phase students develop the critical thinking, technological skills as well as communication and collaboration skills.

Figure 1. The android application "Energy Consumption"

2.3. Do phase

In the last phase students working in pairs designing a poster and build a STEM construction with two small photovoltaic panels. Additionally during this last phase students discuss in the class what they have done, reflect upon the problem, propose solutions and conclude. Creativity and innovation are developed in this stage and students create something that is meaningful and impactful for them and for their families.

3. Other schools

This training scenario was created during the first year of the "Connect" project, alongside some other training scenarios created by colleagues. During the next two years of the project, colleagues from schools entering the project were able to choose one of these or create a new scenario of their own. The Renewable Energy Sources scenario was chosen by 25 other educators making it one of the most popular scenarios among teachers. They used the android application as well as the questionnaires and the escape game. Moreover, they adapted it in their local needs and then implemented it in their classes. Many of these schools participated in the Greek student conference of Connect and they had the opportunity to disseminate their work. Furthermore, each educator choosed scientists from the Greek Universities, specialized in renewable sources (i.e. wind energy, geothermal energy, photovoltaic systems etc) to discuss with students and answer their questions.

4. Conclusions

The Connect project has brought significant benefits for students, forstering a transformative educational experience. One of the advantages lies in the observed enthusiasm among students. Furthermore, the involvement of families and the integration of scientists into the educational process have enriched the students' learning enviromnent. Students within Connect are better equipped to contribute to sustainable solutions, making a positive impact on their communities and beyond. But apart from the general characteristics of the Connect project, it is worth sharing some thoughts and experiences from the implementation of our own scenario, as well as from the discussion with colleagues who have chosen and implemented it with their students.

The success and popularity of an open schooling activity depends on two important key points, the first concerning students and families and the second concerning educators. The active or non-active participation of pupils and their families in open schooling activities is directly related to the subject of the activity. The issue of energy consumption and renewable energy sources suddenly became a hot topic in everyday life after the outbreak of the war in Ukraine and its impact on Europe's gas supply. Moreover, the choice of implementing a scenario or not depends on the teacher. In an educational system, such as the Greek one, with an inflexible curriculum, the second factor relates to the ease with which it is integrated into the course syllabus. Our scenario is implemented easily through the Greek curriculum. In conclusion, we believe that our scenario fulfills both two important key points.

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The role of coaching in supporting schools to adopt open schooling

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Abstract

This paper presents the idea that coaching can play a crucial role in facilitating the adoption of open schooling by educational institutions and investigates the methods through which it can achieve this. The typical difficulties of open education are discussed, and a brief comparison is made between coaching and other similar interventions like psychotherapy, teaching, mentoring, and training.The paper adopts the perspective of a teacher transitioning into a life coach and delves into the advantages of coaching for both students and educators as they embrace the principles of open schooling. The paper encompasses a range of strategies by which coaching can support educators within the framework of open schooling. Furthermore, it examines how coaching can aid students in putting open schooling principles into practice.In summary, the paper underscores the pivotal role that coaching plays in facilitating the successful implementation of open schooling, helping teachers and students get the most out of it.

Key words: open schooling, open schooling challenges, coaching, educational coaching

Introduction

While there is quite a lot of information on coaching in education in the literature, I have found little specific data on the combination of coaching and open schooling, but I strongly believe that bringing them together would enhance the quality of the educational process.

Open schooling promotes a flexible and inclusive learning environment that encourages students to explore the world through science, an approach to education where students identify real-life problems that they CARE about, want to KNOW and DO actions as to find out solutions collaborating with their communities and science professionals. (CONNECT project n. d.)

Coaching is defined by the European Mentoring and Coaching Council as "supporting clients in achieving greater self-awareness, improved self-management skills and increased self-efficacy, so they develop their own goals and solutions appropriate to their context". (Robins 2017, p. 121) As the ICF states, "The process of coaching often unlocks previously untapped sources of imagination, productivity and leadership". (ICF, n.d.) Elaine Cox, senior lecturer within the International Centre for Coaching and Mentoring Studies at Oxford Brookes University, defines coaching as a "facilitated, dialogic learning process". (Bennett and Campone, 2017)

In fact, the term "coaching" appeared in the education aria in the 1830s at Oxford University, where a student support activity was initiated for students to take the exams. (Stănciulescu, 2021) Thereafter, academic coaching principles were barrowed in performance sports, then performance business (Rosha 2014, p. 119; Stănciulescu, 2021) and nowadays coaching is used in various fields (Pürçek, 2014, p. 1), including education, where the popularity of coaching is on the rise.

Coaching is a future-oriented intervention that can serve as a valuable tool, providing support to schools in adopting open schooling and addressing the challenges that it faces, benefiting teachers, students, and communities, and ensuring a better future for this approach of education.

This paper can help teachers and school leaders consider coaching in open schooling implementation for an easier and more successful implementation.

Coaching and other professions

Coaching, as previously understood, is a distinct intervention from similar others like teaching, mentoring, training, counselling or psychotherapy. As Rosha (2014) states, "Each intervention has its own purpose and is delivered by experts with different qualifications and different relationships with the individual." All these interventions can be helpful in different educational contexts, used separately or combined.

Because sometimes the word "coaching" is used for mentoring, teaching (van Nieuwerburgh, 2016, p. 1) or training, generating confusion, I will briefly address the differences between coaching and other similar interventions, especially those related to the educational field such as teaching, and mentoring. Coaching shares some similarities with the professions aforementioned, but it has its specific key features.

First of all, coaching is addressed to people who are mentally healthy and have no psychological issues, being distinct in this regard of psychotherapy.

In my opinion, the most appropriate definition for coaching in the educational context is this one proposed by the International Centre for Coaching in Education (ICCE): "A one-to-one conversation focused on the enhancement of learning and development through increasing self-awareness and a sense of personal responsibility where the coach facilitates the self-directed learning of the coachee through questioning, active listening and appropriate challenge in a supportive and encouraging climate." (coachingskills.umn.edu, n.d.) with the mention that coaching conversation could also be a group conversation.

Some differences between classical teaching and coaching are: teaching usually takes place in a formal setting, in a classroom of a school. Coaching usually takes place in a neutral space for both client and coach, and coaching has been taking place more and more online recently.

In teaching, a school curriculum defines the content and skills that students should acquire, coaching involves the beneficiary selecting the theme they want to work on and the results they wish for. The teacher is required to be an expert in the field they teach, while in coaching, the coach is not required to be an expert in the client's field.

The purpose of coaching is to assist individuals in learning, not to teach them. (Whitemore, 2017, p. 13) Different forms of grades and exams are used to evaluate the learning process and student results in teaching, but coaching does not involve grades or exams. In teaching, homework is given to students, but in coaching, beneficiaries are not given homework; to achieve better results, they are encouraged to take responsibility for their own actions. (van Nieuwerburgh and Barr, 2016.) Often, in teaching, students have a passive role in receiving the information taught (Rosha, 2014), while the beneficiary has an active role in the coaching process.

Mentoring in education refers to "a series of one-to-one conversations in which a more experienced person asks questions, provides guidance, shares knowledge, and gives advice to support a learner to improve their performance and achieve success within a nurturing relationship. In addition to being experienced in the area of interest, the mentor should be effective at building relationships and skilled at supporting others to learn." (van Nieuwerburgh and Barr, 2016) Unlike a mentor, the coach doen not necessarily have expertise in the student's field. Other characteristics of mentoring, such as giving advice and providing role models (Rosha, 2014, p. 124) are not found in coaching. Unlike mentoring, which often involves experts providing specific advice or solutions, coaches do not offer solutions or suggestions.

Open schooling challenges

Open schooling aims to bring together diverse sectors (educational, social, enterprise, and cultural) in order to improve the quality of learning for learners (Ramirez-Montoya, 2020) and to equip students with the knowledge, skills, attitudes, and values they need to thrive in the 21st century. (CONNECT International Conference on Open Schooling #CICOS2023, n. d.) In this endeavor open schooling faces many challenges. Some of them are the capacity to bring together schools, local communities, and enterprise for collaboration, lack of access to the internet and technology for many communities (Ramirez-Montoya, 2020), the busy curriculum, and the many duties that teachers need to accomplish on a daily basis. Another obstacle in the open schooling implementation refers to the costs involved by open schooling activities, such the costs of materials used in educational activities or the costs for transporting children to different locations where learning activities take place. On top of that, teachers must take on greater responsibility to supervise students during off-school activities.

Other challenges are the difficulty of accessing resources in a non-native language or finding suitable materials in teachers and students' native language, parents' lack of time to participate in activities with their children, and finding community representatives for collaboration.

A list of challenges refers to "teachers" professional difficulties in implementing this innovative approach to education. In open schooling teachers need to implement or create activities that are different from the curriculum ones, they need to use knowledge that is not used in regular classes and approaches that are different from teaching as lecturing. (Poeck et al., 2022)

In the context of open schooling, coaching can be provided to teachers and students, and I will start with teachers because "teachers' practices in the classroom are the greatest predictor of student achievement", as Knight and Bush state. (Devine, Meyers and Houssemand, 2013, p. 382)

How can teachers benefit from coaching in embracing open schooling?

As we have seen, the implementation of open schooling can be very challenging for teachers, but fortunately, some of the teachers' difficulties in the open schooling context can be addressed by coaching. First of all, open schooling challenges teachers to change and learn, and coaching is a powerful tool in this respect. (Devine, 2013) As Lofthouse (2018) claims, *"*Coaching has been evolving as a form of professional development for teachers and school leaders for several decades, and now exists in many forms." These forms of coaching can be used in an open schooling context assisting teachers to successfully put into practice this approach to education. Evidence indicates that some coaching approaches were already successfully utilized with teachers. (Devine, Meyers, and Houssemand, 2013, p. 1383)

Coaching can help teachers find the necessary time to implement open schooling activities in all the many tasks they have to perform, provide emotional support, and at the same time reduce the negative effects of educational performance (Lofthouse, 2018) diminishing stress and enhancing work and well-being. (Grant, Green, and Rynsaardt, 2010)

Even if it doesn't provide solutions, coaching is a powerful tool for educators to find their own solutions to open schooling obstacles. A great advantage of coaching is that it allows teachers to reflect on their own actions, a very important competence in the world of speed in which we live and in which no one has time.

A coach can aid teachers in understanding the ways in which they require improved skills and embracing innovative teaching approaches. The first beneficiaries of coaching used with teachers will be students, as teachers' coaching can enhance student attainment. (Lofthouse, 2018, p. 11).

Coaching used with teachers can be either individual or group coaching.

How can students benefit from coaching in the context of open schooling?

The 21st century brought its own challenges with it (Devine, Meyers and Houssemand 2013, p. 1382), so the open schooling approach aims to expand the knowledge, skills, attitudes, and values that students need to succeed in this century (CONNECT International Conference on Open Schooling #CICOS2023, n.d.), and coaching has the potential to be very beneficial in this endeavor. There is already evidence to support the use of coaching as a tool for student learning and development. (Devine et al., 2013, p.1382)

There is also evidence to support that coaching positively influences the *"*beneficiaries*"* ability to access the necessary and efficient cognitive processes and metacognitive skills to meet the challenges of the school environment (Brevik Saethern et al. 2022, p.349), skills so necessary in open schooling settings.

Developing the ability of self-directing learning is a priority for students in open schooling, this being the first step in learning to learn. *(*Li-ya, 2003*)* Because in the coaching process they do not feel judged and evaluated, students are more open to the learning process and more available to look for solutions to the challenges they face in self-directed learning.

Research shows that there are many students who believe that science is not for them, and these students lack "science capital", especially those from disadvantaged groups. (CONNECT International

Conference on Open Schooling #CICOS2023 n.d.) This is where coaching comes in helping students to gradually shift from a fixed mindset to a growth mindset.

In secondary schools students are already under stress (Green et al., 2007; Roussis & Wells, 2008) and coaching can help them manage the stress (Devine et al.,2013 p.1386) that can be added by open schooling activities in order for them to enjoy those activities and make the most of them. Working with a coach, students can better manage their emotions, which facilitates learning because learning is dependent on emotional state. (Jim Kwik, n.d.)

Students can be helped by a coach to overcome open schooling challenges, boost their efficiency and motivation. (Brevik Saethern et al. 2022) A coach has the patience to work with a child or teenager, which a teacher may not have in certain situations.

Coaching can help students learn for themselves, not just for exams and grades, which classical teaching tends to fail. (van Nieuwerburgh and Barr, 2016, p.1). Coaching with students can be done individually or in a group.

Conclusions

Coaching is an intervention that has already been successfully used in education for both teachers and students. In the context of this paper, coaching is distinct from other similar interventions like psychotherapy, teaching, mentoring, or training, and it is important to be aware of these differences in order to understand which of them, alone or combined, is better to be chosen in order to enhance the quality of education in the 21st century.

Because it addresses some of the difficulties that open schooling faces, coaching can be very helpful in putting open schooling into practice for both teachers and students in a variety of ways. Combining coaching and open schooling can enhance the educational process, but further research is required to gather more evidence-based knowledge about how coaching can support open schooling.

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Open Schooling: transforming the school curriculum through science education

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Abstract.
This article describes a project developed in Bahia during the last three years that involves basic educational schools, students and they families, teachers, policy makers, enterprises and scientist from universities. This project, called Connect, benefited almost two thousand students in Bahia – Brazil with more than 30% of them completing scientific action reports using the Care-Know-Do methodology. Open schooling, with a focus on science education, has allowed students to access a wide range of scientific knowledge and engage in practical experiences and real-world challenges. The open schooling approach has not been limited to traditional classrooms, giving students the freedom to explore topics of interest and collaborate with peers. The schools involved in the project addressed different topics, with a strong connection to global sustainability issues. The project also promoted closer ties between universities and schools, involving researchers and scientists in basic education activities. Furthermore, families got involved in the activities, and the participation of the local political class was notable, suggesting the possibility of integrating the principles of open schooling and responsible research and innovation into public educational policies in these municipalities.

1. Introduction

This article portrays the conception, development and results of an international educational action that involved five countries in Europe and Latin America, lasted three years and reached significant numbers of participants. This is an initiative built with the participation of universities, government and private institutions that designed a project called CONNECT - including open schooling with engaging future-oriented science, submitting it to a call for the Horizon 2020 Program - Science with and for Society

(SwafS), funded by the European Commission and implemented between the years 2020 to 2023. The International Consortium that involved the Open University and Mastery Science - United Kingdom, the Universitatea Valahia Târgovişte - Romania, The Living Lab for Health at IrsiCaixa - Spain, the State University of Bahia and the Pontifical Catholic University of Paraná - Brazil, the Regional Education Directorate of Crete - Greece, GLOBAZ, S.A. - LOBA - Portugal, EXUS SOFTWARE MONOPROSOPI ETAIRIA PERIORISMENIS EVTHINIS - Greece and FONDEN TEKNOLOGIRADET - Denmark. Together and with well-defined roles, all these participating institutions worked to ensure that the established objectives were achieved, the goals were achieved, and the educational, management and evaluation methodologies were implemented.

In 2023, in global numbers in the last year of its completion, according to Okada et. al. (2023), the Connect Project has already benefited more than 30 thousand students, distributed in Brazil (9,349), Greece (3,752), Romania (2,140). in the United Kingdom (910) and Spain (585), countries where activities were carried out in public and private schools. A percentage of more than 40% of these students completed their scientific action reports in line with the Kare-Know-Do methodology, developed and implemented by Connect, applying the open schooling approach and demonstrating the connections established between science and their real life.

This overview presented above had the purpose of presenting the global dimension of the Connect Project, however, the data that will be explored in this section discussed in this article will be focused on the Brazilian experience and more specifically on the project actions developed in Bahia, through the State University of Bahia - UNEB, member of the Consortium, one of the institutions executing the project with schools, as other institutions in the consortium performed management, dissemination, advisory and evaluation functions.

The Connect Project methodology was developed, shared and implemented by all participants and will be described in this article, and this text presents the results achieved in the Bahian cities that were part of it.

2. The principles of the Connect Project

Some fundamental principles were established for the project, including increasing the scientific capital of young people, basic education students, with the aim of awakening interest in science and, consequently, in a scientific career. According to Riley (2005), young people often find science interesting, but do not consider themselves likely to be future scientists, because they lack cultural familiarity with science, they also lack confidence that they can achieve this goal, as well as role models, such as proximity to scientists. Basic education students also lack the opportunity to talk about science outside of school, with their families. “There is evidence that young people with greater scientific capital are more likely to want to stay with science after school” (Riley, 2005). According to the author, a possible solution to awaken young people's interest in science and a scientific career is to make the school open and establish continuous external partnerships with science professionals and families, carrying out projects with university researchers and industry professionals, offering provide them with more authentic contexts to develop skills and knowledge about science and its application.

Aiming to act to transform this reality, it sought to apply a model known as open schooling, with the aim of expanding students' scientific capital, through an inclusive, sustainable curriculum, with participatory scientific action as its main focus, involving families, universities and companies to promote the attitude “science is for me, in life, now and in the future”.

Open schooling, the model chosen for Connect's educational activities, adopted scientific action in the basic education curriculum as the basis of its proposal, presenting challenges for young people to reflect on the survival of planet Earth, sustainable life, teaching them the concept of assessing the life cycle of the products we consume, their environmental impact during manufacturing, use and disposal. This approach to scientific education, brought by Project Connect based on the concept of open schooling, is consistent with what in Brazil we call CTSA education, an acronym for Science, Technology, Society and Environment, which according to Conrado, Nunes-Neto (2019) is practiced and much debated in the field of science teaching, which is referenced in academic research, public

policies and education oriented towards the relationships between science, technology and society. According to Pinto, at. all (2018), in studies on scientific arguments by basic education students, come to the conclusion that young people, despite having good arguments, have many difficulties in developing scientific arguments, even with the guidance of their teachers.

To put open schooling into practice through scientific action in the formal curriculum, five phases were structured: 1. Define the challenge, 2. raise awareness, 3. research and learn knowledge, 4. prepare the scientific action and 5. carry out the action in practice. These five steps are structured in a methodology called the Care-Know-Do framework, a practical structure to integrate formal and informal learning, involving scientific action.

Phase 1, We-Care involves a sensitive and accurate look at the reality around them, also dialogue with families and professionals from universities and companies to identify socio-scientific dilemmas by students with the help and guidance of teachers, leading to elaboration of a scientific question that will represent the challenge to be faced.

In phase 2. WE-Know, students seek formal learning of scientific content that will support them in understanding scientific knowledge on the issue raised, using books, articles in scientific databases, dialogues and lectures with experts from the companies and scientists from universities, always looking for answers and solutions.

Finally, phase 3, We-Do, in which students transform their knowledge and skills into participatory science-action, proposing solutions to the challenges defined in the initial stages.

In addition to the concept of scientific capital and the open schooling model, the Connect Project was based on another important scientific approach, known as responsible research and innovation (RRI), the acronym in English for Responsible, Research And Innovation, understood as an approach that involves researchers, citizens, politicians, companies and organizations to collaborate in research and innovation processes with a focus on responsibility both in the process and in the results, according to the needs and expectations of society(BARDONE; LIND, 2016; COMMISSION, 2013; OKADA, 2008; VON SCHOMBERG, 2013).

3. The principles of the Connect Project

Located in the northeast region of Brazil, Bahia is one of the twenty-seven federative units, with an estimated population in 2021 of approximately 15 million inhabitants and a total area of 564,733 km2. Its capital Salvador was the first seat of the Brazilian government in 1549, by the Portuguese who arrived here in the year 1500 and governed until 1823, when Brazil's independence was consolidated, right here in Bahia, from where the last Portuguese troops were expelled.

The Connect Project's scientific education actions in Bahia began in the first year of its implementation and benefited fourteen schools, involving five municipalities, sixty-six teachers and two thousand, seven hundred and thirteen students.

The territorial scope of the project, as can be seen in the map below, figure 1, contained it in the municipalities of Araci, 222 kilometers from the capital Salvador, Camaçari, 48 km, Candeias 50 km, Irecê 485 km, LAPÃO – 477 km, Presidente Dutra - 495 km and Senhor do Bonfim - 384 km.

Figure 1 - Map of Bahia

In these locations, schools were initially visited to be invited to join the project, they participated in the initial meetings to present the scientific, pedagogical and methodological principles, in addition to the curricular approach of open schooling and responsible research and innovation. In 2021, Year 1 of the Connect Project, two schools, one in the municipality of Irecê and the other in Camaçari, joined the project, with the others choosing to participate in the second and third years, 2022 and 2023.

The projects developed in Bahia can be seen in the table below, figure 2 - Connect number in 2022, which presents the project status in December 2022, knowing that the actions continued and new data will be added in the final report, including the year 2023, as activities to bring together other schools in different cities have continued and are under development.

Column1	Column2	Column3	Column4	Column5	Column6	Column7
			NUMEROS DO CONNECT EM 2022			
Item	Cidade	Escola	Nome do Projeto	Professores	Participantes	Concluintes
1	Bonfim	CESB	Indice de Área Verde-(IAV)- Bairro e Meio ambiente e saúde – as arboviroses	6	97	60
2	Irece	ACM	SUSTENTABILIDADE AMBIENTAL E ENERGIA RENOVÁVEL	5	400	200
3	Irece	ACM	SUSTENTABILIDADE NO COTIDIANO	4	400	200
4	Camaçari	CETEP-RM	Projeto MECADROID - Robótica na Escola com Material Reutilizáveis	1	5	5
5	Camaçari	CETEP-RM	Democratização da Educação Científica e Tecnológica na Escola	2	65	45
6	Lapão	Tiradentes	Meio ambiente: Sustentabilidade e qualidade de vida	2	112	112
7	Lapão	Gaspar	Conciência, cidadania e sustentabilidade	6	284	284
8	Lapão	Valentina	Projeto Plantando o Futuro Valentina Matos	7	221	221
9	Camaçari	CETEP-RM	PROJETO OLIVA - PRAIA SUSTENTÁVEL	2	7	3
10	P. Dutra	Valter Barreto	MEIO AMBIENTE: PRESERVAÇÃO E SUSTENTABILIDADE	3	200	200
11	Lapão	Honorato	MEIO AMBIENTE: PRESERVAÇÃO E SUSTENTABILIDADE	18	234	234
12	Lapão	Deraldo	VAMOS PLANTAR HOJE A SEMENTE DO AMANHA	4	150	150
13	Lapão	M. DOURADO	ESCOLA SUSTENTÁVEL, COMUNIDADE SAUDAVEL	3	170	170
14	Lapão	Elzita Vieira	PROJETO CAATINGA NÃO É DESERTO	3	368	92
Total				**66**	**2713**	**1976**

Figure 2 - Connect Project Board in Bahia

We can see, in the table above, the acronyms of the schools' names, the city where they are located, the number of teachers and students who participated and completed the project's scientific actions, as well as their titles.

In the city of Senhor do Bonfim, which is located 384 kilometers from the capital Salvador, a municipality with eighty thousand inhabitants and a strong cultural tradition, with the June festivals being the best known and sought after by tourists and residents of the city and surrounding areas, CESB - Senhor do Bonfim Educational Center, developed the Green Area Index Project (IAV) - Neighbourhood, Environment and Health - tree viruses. In this scientific action, students took measurements of the city's green areas and carried out calculations to compare with international standards. The results summarize the statement of a student: “Before I thought that the ‘things’ I studied at school were only useful for school... now I think differently”. We can infer that this statement from a young man denotes his change in attitude and understanding of the meaning of school education. It demonstrates that the knowledge constructed will be useful in your life and not just at school.

In addition to this project, registered on the Connect Platform, scientific education through open schooling led to other actions at CESB. Scientific actions were carried out through several other projects developed by students based on their interests, highlighting Physics, “Movement Study”, Accessibility at School was researched, with a movement simulator, experiencing in practice the use of ramps by disabled people, presenting improvement proposals to the school management; on “numbers and mathematical functions”, the Unified Health System (SUS) was investigated, with a survey on the topic “Aedes in Focus”, involving 89 (eighty-nine) people from the community who answered a questionnaire about the importance of the SUS . The action was a public awareness campaign. Also, in health, it dealt with Teenage Pregnancy, involving families, the community and companies in a “Health Fair”, Sexual Education and Pregnancy Prevention. In the area of environment and sustainability, combating wild animal trafficking with teaching zoology and environmental education in schools, with scientists in the field of biology “Vertebrates and Conservation”.

In the municipality of Irecê, 485 kilometers from the capital, the Antônio Carlos Magalhães Municipal School (ACM). This school was a pioneer in the region and began its work with the Bird Rewilding Project of the Semiarid Northeast of Brazil.

Figure 3 - Public campaign to free the birds

The rewilding project consisted of the analysis of the Phyto physiognomy of the caatinga in urban spaces, a practical study, identification of caged birds in the city of Irecê, exhibition of the study carried out at the event open to the community, entitled Knowledge Fair, awareness campaign on the topic covered in a public square in the neighbourhood where the school is located.

In the second year, having chosen the global theme Zero Carbon, through the Sustainability in Everyday Life Project, the school involved students and teachers of basic education in the areas of Natural Sciences, Human Sciences, Agroecology and Environmental Sciences, Wind Energy Generation, with the participation of researchers specializing in Rural Education. The Project was carried out in three stages, following the Care-Know-Do methodology. In the "CARE" Stage, a Based on reflections in the classroom and dialogues with families, 8th and 9th grade students realized the need for changes in consumption and eating habits to preserve life on the planet.

After a live broadcast with experts and scientists, many discussions in the classroom, two socio-scientific dilemmas were prioritized: materials that are inappropriately discarded in nature, causing pollution and the issue of the use of pesticides on vegetables, a very common practice in the region. In the KNOW" Stage, The students researched the impact that inadequate plastic disposal causes on the environment, learned about plastic islands in the oceans and identified that these large global impacts are caused by small local actions. They also carried out studies regarding the impacts caused by the use of pesticides, both the impacts on the environment and people's health, they acquired knowledge about ways of growing vegetables without the use of pesticides and how to produce natural fertilizers from composting.

Figure 4 - Organic Planting at School

In the DO Stage: the students three actions: 1. PLASTIC MATERIALS COLLECTION CAMPAIGN – The class teacher got in touch with a group that collects recyclable materials, the students carried out a campaign to collect these materials with other classes at the school and with their family members; The material collected was sold and the amount raised was used in a tour with all participants as a form of incentive and prize. 2. SUSTAINABLE CLEANING CAMPAIGN – Upon learning of the damage caused by the inappropriate disposal of multi-purpose sponges, made from synthetic and non-biodegradable material, the students promoted a campaign to replace these sponges with natural biodegradable materials, presenting these options even to canteen employees. 3. ORGANIC GARDEN AT SCHOOL – The students built a vegetable garden in the school nursery, (figure 3, above) chose the vegetables and carried out the entire process: soil preparation, fertilization with organic compounds,

planting, monitored the growth of the vegetables, harvested and delivered to the school canteen to supplement the lunch.

In the municipality of Lapão, 477 kilometers from Salvador, adherence to the Connect Project was organized by the Department of Education with the involvement of seven schools in the municipal network, generating a large movement of transformation of curricular practices with the involvement of a large number of teachers, students, families and rulers. The Tiradentes, Elzita Vieira, Antonia Gaspar, Honorato Gaspar de Souza, Deraldo José de Souza, Manoel Dourado and Valentina Matos schools, all of basic education, coordinated projects, which took as their central theme the global challenge of Carbon Neutral and carried out projects aimed at the environment, sustainability, quality of life, citizenship, nature preservation and planting seedlings and seeds on the outskirts of the city.

Activities related to the curriculum were carried out and proved to be extremely important, relevant and challenging, as they were carried out in the post-pandemic period, which determined social isolation for a long time, but the active participation of the entire school community and local society, resulted in representative work from the beginning of the preparation, the elaboration of the project and its culmination in the Children and Youth Conference, held in the municipality. Open Schooling proved to be very challenging and useful for teachers, students, staff and school leaders, because the project was carried out in an interdisciplinary way involving all disciplines and members of the community. The results were evidenced by the active participation of students from the elaboration of projects to the production of materials until the final result. Student Ruan Afrisio mentioned in his speech about Connect's actions that “We must become aware that we need the environment to be looked after and preserved to live healthier”.

Figure 5 - The various stages and actions of Connect in Lapão

In Lapão, the steps of the Care-Know-Do methodology were also followed and the activities were carried out in three major stages: In the first, “CARE”: students were challenged to critically observe real-life problems that affect their community, talk to their classmates, family and teachers to understand the need to take care of the environment around them and analyse residents' actions aimed at preservation of the Environment and the surroundings of Lagoas and Canões.

Early Childhood Education and Elementary Education I and II students, aged between 3 and 15 years old, participated in the activities. In the KNOW” stage, students researched topics related to environmental preservation, used knowledge about environmental preservation and sustainability, developed practices to take care of the place where we live, value the importance of collective work, scientific research and forms of production without aggression against nature.

In the DO step: the students prepared various texts, read, prepared pamphlets and posters, participated in lectures and the Children's Conference, planted several seedlings, distributed them to the

community with the support of the Secretariat of Environment and Agriculture. They participated and completed collective and individual activities and were supported by families and community members.

In the city of Presidente Dutra, also in the Irecê Identity Territory, a municipality 495 kilometers away from Salvador, the project developed was Environment: Preservation and Sustainability, an initiative based on the principles of Open Schooling about caring for the place where we live. Managers, teachers and basic education students participated, as well as other professionals from the Valter Barreto Municipal School. The activities included science professionals and were supported by the State University of Bahia (UNEB). The purpose of the project is to support scientific education in basic education, especially for the inclusion of students in situations of social disadvantage, increasing their scientific capital and awakening interest in science. The three stages of Connect - Care-Know-Do, which translate into an initial awareness-raising activity (care) about real socio-scientific problems, then research to know and propose scientific actions based on facts and data and the third stage of acting that means to do something in search of a solution to the problem studied.

In the "CARE" Stage: students were challenged to observe their community, both the place where they live, the school and its surroundings, aiming to identify problems that affect life in society (socio-scientific dilemmas) and that are relevant to be studied in search of solutions. The real-life problem that they decided was most important for this study, after debate and prioritization among everyone brought to the project meetings, was the lack of care and preservation of the surroundings of the lagoon and dam in the city center. The students who participated in the activities were in the 6th to 9th year of Elementary School, aged between 11 and 15 years old.

In the KNOW" Stage: students researched knowledge about the preservation of waters, life and the preservation of aquatic species and their importance for the environment, built at this stage through research, participation in lectures, readings and classes on the topic, which dealt with the preservation of the environment. There was a debate on the development of sustainable practices to take care of the place where we live, realizing the importance of collective work, mutual respect, knowledge of environmental practices to take care of the environment, various research on the topic and others.

Figure 6 - Lagoon protection activity in Presidente Dutra

In the DO Stage: In the end, the students prepared different texts, different readings, posters, banners, participated in walks and lectures, planted seedlings, distributed different seedlings to the community with support from the Departments of Environment, Education and Agriculture, and others. They completed the activities in groups in partnership with families and community members.

In the municipalities of Camaçari and Candeias, both in the Metropolitan Region of Salvador with an average distance of 50 kilometres from the capital, several projects were carried out following the principles of open schooling and the Connect methodology. The Territorial Center for Professional Education - CETEP-RM is headquartered in both cities and its units worked together, bringing together

teachers and students in carrying out projects. This vocational high school joined Connect from the first year of its implementation and added to its scientific education experience, which was already quite significant, including the organization of an Annual Scientific Fair, called FECITESC, in which students exhibit of the work developed throughout the academic year and is evaluated by external examiners, receiving awards and certificates recognizing their performance.

Adding the principles of the Connect Project, students identified problems and sought solutions, supported by scientific research, promoting confidence and aspiration to pursue scientific careers, through practices based on socio-scientific dilemmas, with the guidance of professors and guest scientists, to discuss real problems. The research activities with the students materialized in projects such as educational robotics with recyclable materials, science teaching in basic education, public lighting, manufacturing of lamps from reused palm oil, public security and lighting, manufacturing of biodegradable plastics from microalgae, financial education, sustainable beaches and bioplastics from cassava remains from the city's street market. These projects stood out as important actions developed based on real problems, translated as socio-scientific dilemmas and studied under the methodological guidelines of the Connect Project.

The SUSTAINABLE BEACH Project was an exploratory research, with active interventions on beaches in Camaçari-Bahia, aiming to raise environmental awareness among the local community and tourists. The field study, using questionnaires and collecting seawater samples, images and waste found, found that the beaches were suitable for bathing, without coliforms, but there were no garbage collectors in the sand, only on the sidewalk. A letter to the local city hall requested environmental impact actions.

Figure 7 - Sustainable Beach Project Activity

The FEIRA RAÍZ Project focused on the adequate disposal of organic cassava waste, which contains a significant amount of starch, generated at the Camaçari open-air market, enabling the production of bioplastic through polymerization. In the environment, organic materials degrade spontaneously and recycle nutrients in processes such as the carbon and nitrogen cycles, but when disposed of inappropriately, they can cause serious risks to the environment, the health of the soil, water, air, exposing the population and animals to toxic and pathogenic substances and generate waste of raw materials.

Figure 8 - Feira Raiz Project Activity

The work provided an opportunity to spread knowledge about the responsible disposal of waste, contributing to the general well-being of the environment. The evaluation instrument was answered by 27 CETEP students, seeking to obtain opinions about science and their participation in the project. Regarding science being useful for life, 89% agreed and 12% said they were unsure, highlighting the need to carry out actions to develop and strengthen experiences that stimulate critical reflective thinking and promote the scientific capital of young people at school. Regarding the best experiences with participating in the project, a student's statement caught our attention: "step by step on how it starts, how it produces, how members should be guided and how to play a good role as a leader", highlighting the phases of preparation and implementation of the CONNECT project, and the "CARE-KNOW-DO" methodology.

In another statement about learning science, the student said that "unfortunately it is a little publicized area, I believe that if we could promote more, there would be more people in the area, as it is an exciting activity for the brain, opening the eyes to the world, demonstrating interest in science". In other words, students are empowered with knowledge, skills, attitudes and values as subjects who can transform their lives, the environment and their communities through challenges that are relevant to them (CARE), knowledge learned, researched, discussed (KNOW) and transformative actions (DO). Finally, there was a great involvement of teachers, students, families and communities with the proposed themes, highlighting the importance of open schooling and science education, as key elements for greater social and environmental awareness.

4. Conclusion

It was observed that the open schooling approach with a focus on scientific education deepens scientific knowledge in different areas, among young people in basic education, through interdisciplinary activities. Not only does it allow students to access a wide variety of scientific knowledge, but it also engages them in practical experiences and real-world challenges. In open schooling, science teaching is not restricted to traditional classrooms. Students have the freedom to explore topics of interest and dive into projects that involve scientific investigations. They can collaborate with colleagues, use online resources, and actively participate in building their own knowledge.

Attention was drawn to the variety of themes chosen by the schools, as well as the connection of these themes with global themes of the planet's sustainability. It can be seen in the description of the projects that the issue of life on land and water, the production of clean energy, protection of natural

resources, cleaning of the oceans, assessment of green areas in urban locations, combating the irregular disposal of plastics and other waste, organic platinum, protection of animals and habitat, among others. It is also worth highlighting the close relationship between the chosen themes and socio-environmental issues and local socio-scientific dilemmas, around the school, in the communities where the students live and even in the management practices of the school space itself.

Many Connect Project actions caused positive impacts in the different realities where it took place. We can highlight, in addition to the learning and changes that took place at school, its pedagogical practices that are renewed, the approach to the university, the participation of several researchers, scientists in basic education activities, going to give lectures or even participating in stages of presentations and evaluations of project results.

It is also worth highlighting the involvement of families who were present in activities, science fairs, fieldwork and certifications and recognition of the work carried out by students.

The participation of the political class stood out in the Bahia experience. Mayors, education secretaries and their advisors, deputy mayors, councilors were involved with Connect's scientific actions. Certainly, the principles of open schooling and responsible research and innovation have the possibility of integrating public educational policies in these municipalities that participated in Connect and the university will monitor this. There are already invitations to present the Project at pedagogical meetings in some municipalities and we will be contributing in this way to influence municipal education plans.

The statistics generated by the application of questionnaires answered by students, unfortunately in smaller numbers, only 728 (seven hundred and twenty-eight), 26.83% of the 2713 (two thousand seven hundred and thirteen) effective number of participants, motivated by the difficulty of accessing Electronic devices, such as computers, tablets and cell phones connected to the Internet, still provide data that can reveal how much of these changes reported above actually occurred. The age group between 11 and 16 years old predominated with 90% of the participants, with fourteen years old being the largest of them with 29.67%. Regarding gender, 53% were women and 46% were men. The comments recorded by these students in their responses 56% of them agree that science will be useful in their lives, 43% declare that they feel confident in using the scientific approach to formulate questions and ideas about real socio-scientific dilemmas. It is also noteworthy that 41% are confident in their scientific knowledge, 39% say they know how to justify their point of view using scientific arguments, 46% say they are confident in doing/participating in scientific projects, 37% in talking about science and 56% said that learning science is fun, 36% said they would like to work as a scientist and 34% would like to be seen as an expert in science. All this data in greater detail is published in the Connect Bahia Brazil report, on the Student report link, available at CONNECT - Google My Maps.

In the open answers, one of the students stands out who stated: “I learned that it is necessary to analyse and research to reach a conclusion, but that sometimes we do not reach an exact answer”. Among other statements representative of Connect's actions, we note that this is very emblematic, as it reveals the development of true scientific spirit, of incessant search for answers, but of the benefit of the doubt as a scientific attitude, summarizing well that scientific actions brought good results in changing attitude towards increasing the scientific capital of these young people.

In the same link you can read the teachers' responses and the global report from Bahia, which provide revealing data on how important this project was, not only for the students, but for the teachers as well and for the schools.

Finally, we can say from our position as the Project coordination team in Bahia that we followed every action, every planning, the uncertainties and difficulties that arose along the way, the creative ways of overcoming them, that the Connect Project made an impact on local education. where it happened and leaves a great potential, as its effects will not end with the conclusion of the three-year period already established in its schedule, but will continue, in the lives of students and teachers, as well as in schools. The same can be said for universities, as we have made commitments to continue our actions with schools, and we even have another project approved by a Brazilian research body, involving a network of seven universities, including UNEB and PUC-PR, which aims, together with five other

Brazilian universities, to implement projects with an approach to open schooling, responsible research and innovation and scientific education.

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Operationalising Open schooling on Scale for Science and Sustainability Curricula: The case of Greece

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Abstract. Open schooling is a term promoted by the European Union that refers to schools as agents of community wellbeing. However limited attention has been paid to examining how to adopt and scale up open schooling to make it sustainable. In this study, we present our way to operationalise open schooling on a large scale by creating agile, written by teachers, led by theory, coached by experts, curriculum resources that exploit the existing curriculum and school context (bottom-up approach). It was a 3-year effort in the context of the CONNECT project implemented in Greece where more than 142 schools, 340 teachers and 5390 students implemented open schooling for Science and Sustainability curriculum in each kind of school. First, we present the principles and the guidelines set, in order to create the open schooling educational resources. Then, we present the educational scenarios written by the teachers and how they were implemented. Then, we present some results from a questionnaire that is given to students for us to understand what kind of activities took place in this large scale open schooling implementation, what was the students' school level and the level of students' acceptance of the program. We finally discuss and conclude focusing on emerging insights on how to scale up open schooling and make it sustainable in existing school settings with implications on local, regional, national and global educational policy.

1. Introduction

Open schooling is a term promoted by the European Union [1] that refers to schools as agents of community wellbeing. As Okada & Gray [2] underlines, the European Union has funded more than 15 projects on open schooling to enhance science education towards sustainability in Europe. However as the same authors claim "limited attention has been paid to examining how to adopt and scale up these initiatives to make them sustainable".

Okada & Gray [2] and Mulero, Cunill, Grau & Mancho [3] also claim that most of the times open schooling implementation contradicts traditional curricula. Okada et al. [4] found that this is the case mostly on educational systems where the curriculum is focused on exams. Mulero et al. [3] conclude in their work that the main obstacles for implementing open schooling in schools are (a) the division of the curriculum by subjects, each with their own structure and contents, whereas in real life issues are not divided into subjects, (b) in secondary education, the strict, traditional confines of different classes which prevents addressing issues in a more realistic overarching way and finally the (c) lack of available time to line up course contents.

In this paper, we present our way to operationalise open schooling on a large scale by creating agile, written by teachers, led by theory, coached by experts, resources that exploit the existing curriculum and school context. It was a 3-year effort in the context of the CONNECT project implemented in Greece where more than 142 schools, 340 teachers and 5390 students implemented open schooling for Science

and Sustainability curriculum in 12 out of 13 regions of Greece in each kind of school (Primary education, Secondary education, Special Educational Needs Schools, General schools, Vocational schools, very small schools in a small island or high on the mountains, big urban schools).

The aim is to discuss a set of principles that could assist teachers and policy makers in creating and implementing open schooling curriculum resources that fit the school context using mostly a bottom-up approach.

First, we are going to present the principles and the guidelines set in order to create the open schooling educational resources. Then, we are going to present the educational scenarios written by the teachers and how they were implemented. Then, we are going to present some results from a questionnaire that is given to students for us to understand what kind of activities took place in this large scale open schooling implementation, what was the students' school level and students' acceptance of the program. A discussion will follow focusing on emerging insights on how to scale up open schooling and make it sustainable in existing school settings using mostly a bottom-up approach but also with implications on local, regional, national and global educational policy.

2. Operationalising open schooling by writing and implementing theory-based open schooling resources

2.1. Educational resources design principles and guidelines

Following theory and practice on open schooling [1-2, 4, 5-8] in the context of the CONNECT project (https://www.connect-science.net/) we created a set of guidelines for authoring and implementing an educational scenario for operationalising the theory of open schooling in context but also in scale. The principles and guidelines are presented below:

1. Students and teacher have to study a real problem or challenge, global or local, that can be studied using Science or STEAM
2. The educational scenario is connected to the curriculum or can be implemented in extra-curricular activities in the school context (environmental school activities, science clubs etc.)
3. The educational scenario follows the model Care-Know-Do [2]
4. Students and teacher are supported by an expert on the field of the problem/challenge and are also encouraged
5. to engage other stakeholders of the community (decision makers, research centers, universities, museums, NGO's, industry) in any phase of the Care-Know-Do model is appropriate
6. The educational scenario involves the family of the students in any phase of the Care-Know-Do model is appropriate
7. The educational scenario aims at least one of the 17 goals of sustainable development of the United Nations.

2.2. The educational scenarios written and implemented by teachers

Teachers had initially access to 5 educational scenarios written by CONNECT's expert teams two (2) structured ("Rewilding", "Carbon Neutral") plus three (3) open ended scenarios ("jury", "consensus", "co-creation") but in order to scale up and sustain open schooling, teachers were given the opportunity to write their own scenarios or translate and customize other CONNECT scenarios written in English that fit in their needs. Finally they chose two (2) more scenarios: "Microplastics" by MasteryScience and "How does hand washing relate to the risk of contamination?" by IRSI.

Following the above mentioned design principles and guidelines and coached by curriculum experts of Regional Directorate of P&S Education of Crete (RDE), some teachers have written educational scenarios-science actions which they shared with the others teachers through the CONNECT platform (https://connect-eu.exus.co.uk/) [9]. Twenty-One (21) educational scenarios were written by teachers and approved by RDE experts and uploaded in the CONNECT platform and twenty (20) of them were implemented in schools. Three (3) more implemented scenarios have not been uploaded yet. In total, 20+5+2+3=30 educational scenarios were implemented throughout these three (3) years. You can see

below the 20 educational scenarios written by teachers and uploaded on the platform and how they were implemented in Greek schools (Table 1).

Table 1. The educational scenarios written by teachers

Name	**Curriculum according the description of the scenario**	**School level**	**Curriculum according on how it were implemented in practice**	**Teachers involved in implementation**
Renewable energy sources	Physics and Geography	Lower Secondary Education	Physics	Individual
Polymer plastics	Chemistry	Upper Secondary Education (11th Grade)	Chemistry	Individual
Creating & Using maps for Problem Solving	Geography	Lower Secondary Education (7th Grade)	Geography	Individual
Plastics and Food	Chemistry	Upper Secondary Education	Chemistry. with additional activities following the students' interests and current affairs	Individual
Aerosols in Virus Transmission	Chemistry-Biology-Mathematics-Computer Science	Secondary Education	"School activities" (environmental, health education, school and professional orientation, cultural) Interdisciplinary and interdisciplinary way.	Group of teachers
Wildlife in Greece: Dangers - Threats - Protection	Environmental Studies - Science - Geography - Skills Labs	Primary Education	Skills labs	Group of teachers
The coastal and marine ecosystem of my place	Environmental Studies - Science (Φυσικά) - Geography - Skills Labs	Primary Education	Environmental Studies - Science (Φυσικά) - Geography - Skills Labs	Group of teachers
Global Warming and Chemical Pollution	Geography, Physics, Chemistry, Skills Lab	Secondary Education & Primary Education	Physics of Lower Secondary School	Individual, Groups of teachers
Discovering the natural wealth of my place: sustainable environmental and mythological routes	Cross-curricularly linked to teaching units of Environmental Studies, History and Language. In the 5th grade, the course of Geography and Social and Political Education is used, and in the 6th grade it is connected with the course of Social and Political Education, Geography and Language.	Primary Education	1st implementation (Language, History, Social and Political Education, Geography, Visual Arts, Informatics and Theater Education) 2nd implementation(Informatics, Arts, Skills Lab)	Individual, Groups of teachers

Urban Planning from the perspective of students	Statistics (Mathematics), History Informatics	Primary Education & Secondary Education	Statistics, History, Informatics , Visual Arts	Individual
I learn about light and use it through photography to capture the problems of my place	Science and Geography	Primary Education	Science and Geography & Visual Arts, Creativity and innovation Clubs	Individual
In a handful of sand…	Biology, Geology Physics Chemistry. As far as Elementary is concerned, Environmental Studies, Science-Geography courses. Arts	Secondary Education & Primary Education	Biology, Geology Physics Chemistry.	Individual
Marine food chain. The big fish eats the small fish	Environmental Studies, Science	Primary Education	Environmental Studies, Science	Individual, Groups of teachers
Machine Learning and Image Recognition in the Service of the Environment	Informatics	Secondary & Primary Education	Informatics	Individual
Blue growth: the macroalgae	Biology, Geography, Chemistry	Lower Secondary School	School activities	Group of teachers
As long as I live I work out...	Physical education, Informatics, Skills Lab, Visual Arts	Primary Education	Physical education, Informatics, Skills Lab, Visual Arts	Group of teachers
Is waste garbage?	Chemistry, Biology	Lower Secondary Education	Chemistry, Biology	Group of teachers
Climate change: past, present and future	Chemistry, Biology, Skills Lab	Lower Secondary Education	Chemistry, Biology	Group of teachers
Humans and Robots	Creative Activities Zone, Projects in Technology, Informatics (Vocational High school)	Vocational School	Creative Activities Zone, Projects in Technology, Informatics (Vocational High school)	Individual
Composting: Together we can do more	Special Educational Needs Schools curriculum	Special Educational Needs Schools	Special Educational Needs Schools curriculum	Group of teachers

As we can see in Table 1 open schooling in more than 142 schools, 340 teachers and 5390 students in Greece were connected to existing curriculum exploiting (a) each Science subject lesson of Greek curriculum: Science (Φυσικά) and Geography in primary education, Physics, Chemistry, Biology,

Geology, Geography in Secondary education, (b) other STEAM subjects lessons such as Informatics, Mathematics, Visual Arts, Language, History, Social and Political Education, Physical education,

Theater education and (c) project-based or inquiry-based subject or problem-based compulsory courses such as “Skills Lab” in Primary and Lower Secondary Education, “Environmental studies” in primary education, “Creative activity Zones” and “Project in Technology” in Vocational High School and “Special Educational Needs Curriculum” in Special Educational Needs schools. Also, students and teachers implemented some scenarios in the extracurricular, optional, but recommended by the Ministry, "School Activities" and "Creation and Innovation Club" courses.

In this way, the needs of each type of school were met having teachers working either individually or by groups including interdisciplinary ones (Table 1).

2.3. Topics discussed, activities implemented and students’ acceptance

Each year, after the implementation, students were given a questionnaire. Among a lot of questions students were asked:

1. You participated in CONNECT activities in the following topics: select all that apply: (a) Environment, (b) Health, (c) Energy, (d) Climate change, (e) None, (f) Other
2. In which of the following activities have you participated (with your classmates, family or scientists)?: (a) Discussion, (b) Deciding a topic, (c) Asking questions, (d) Voting, (e) Research, (f) Developing a project, (g) Creating recommendations, (h) Presenting results, (i) other.
3. Would you like to participate in new activities such as the ones you have implemented?

After the implementation of the 3rd year, two thousand one (2001) students of all grades from all over Greece have answered:

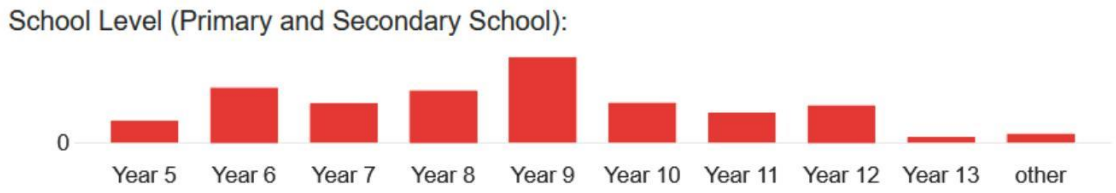

Figure 1. Students’ Year of Studies

The results in Question 1, 2 & 3 are presented below:

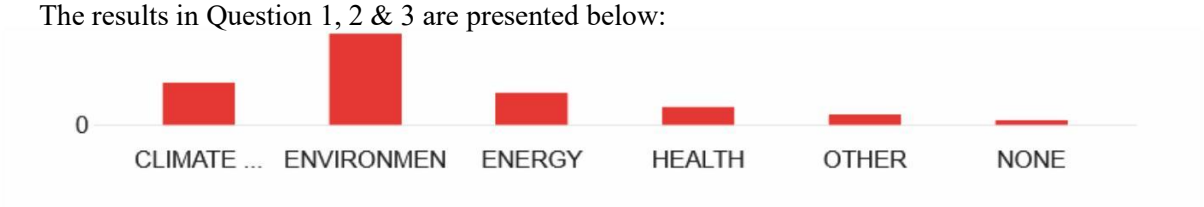

Figure 2. Answers to Question 1

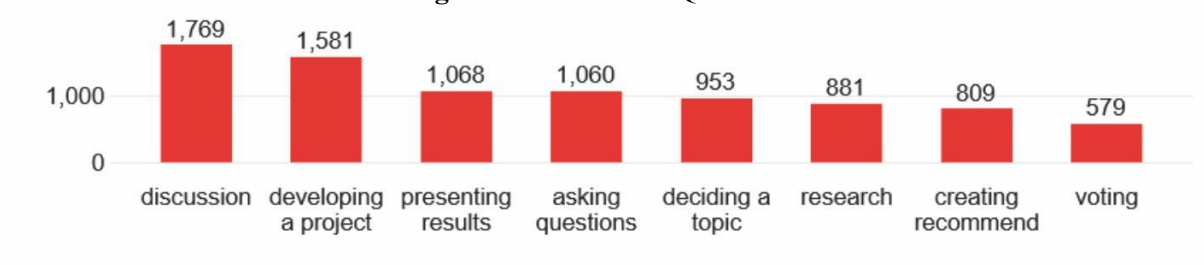

Figure 3. Answers to Question 2

Figure 4. Students' acceptance of open schooling

3. Discussion-Conclusions

It is clear that since CONNECT was approved by the Ministry of Education to be implemented in Greek schools as one of the dozens of programs approved each year, teachers jumped at the chance. Did they have the opportunity to do multiple programs at once? All these three (3) years we have had the opportunity to create a community by meeting synchronously with Zoom and phone calls with the teachers and asynchronously through the platform and emails [10]. 90% of the teachers had answered the previous question that they did not have time to do more than one program and that was CONNECT.

1. But why did they choose CONNECT among all these approved programs, and above all how did they manage to implement it to the end?
2. Why did we have participation and success even from the 12th grade, that is, from the grade in which the children take the Panhellenic exams for admission to universities (Figure 1), whereas in other countries in CONNECT that was not the case [4]?

We claim that the answer is based on the data of the previous section:

First, each teacher was given the opportunity to meet their needs, including curriculum requirements, either by using a ready-made scenario that they adapted or by creating their own. But how? Because they were given theory-based principles and design guidelines and also the opportunity to be coached by curriculum experts who were giving them feedback. In this way, every relevant subject of the Greek curriculum was taken advantage of, as well as the optional extracurricular activities.

Second, in more than half of the cases (Table 1), teachers worked together to implement cross-curricular educational scenarios taking advantage of project-based/inquiry-based subject /problem-based compulsory courses and optional extracurricular courses. The latter case agrees with the recommendations of Mulero et al. [3] on sustainable open schooling, about interdisciplinary groups of teachers especially if the curriculum is strict.

Third, technology helped for (a) coaching and co-creation of resources (b) collaboration among teachers and also (c) bringing 82 experts and other stakeholders “close” to students through teleconferences.

It also needed both intrinsic and extrinsic motivation [11, 2]. Teachers were intrinsically motivated by seeing their students owning the learning process by discussing, doing projects, presenting results at the CONNECT Student Conference (https://connect.pdekritis.gr/studentconference2023/) and other forums, by deciding topics etc. (Figure 3).They were also intrinsically motivated by sharing their work with other colleagues. They were also extrinsically motivated because they were acknowledged through certificates and credits they have received for their authoring work.

But how was open schooling implemented in this context? Was it inquiry-based as Bogner & Sotiriou [11] and Okada et al. [4] suggest for Open Science Schooling? How were the topics selected? Our data (Figure 3) shows that for students it was a project-based approach. The topic was most often predetermined by the teacher (Table 1), but half of the time, left the students with the opportunity to guide the procedure of learning by choosing the subtopics. We assume that this was to ensure that it fit the curriculum. Students’ perceptions about the kind of activity they have participated in can be explained because inquiry-based, project-based and problem-based learning share the same theory of constructivism [12].

Was it Open Schooling in Science Education what we have done? Our scenario design guidelines and the data show (Table 1, Figure 2) that although the topics were aimed at the 17 goals of sustainable

development, students perceived that it was mostly about the environment or climate change. I guess this is not bizarre if we hypothesize that by adopting "open schooling for sustainability" we are transferred from "Science Education" to "Science education for sustainability" where the notion of Environment has a more generic meaning.

Therefore, we could conclude that the implementation of the open schooling in Greece through the CONNECT project was rather a successful in terms of student's acceptance (Figure 4), large-scale, bottom-up endeavour supported by curriculum experts and legitimized by the Ministry [2], which was adapted, strengthened and limited by the Greek context.

Acknowledgments

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Environment and sustainability – studying Green Area Index - (IAV) - Neighborhood and Environment and health – arboviruses in the context of my neighborhood.

DOI: 10.5281/zenodo.10196128

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Fabiana M. Esteves, – Mathematics ;
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Vanilton Miranda Nunes- Biology
Camila Brito - Scientific Initiation

Abstract: This pedagogical practice within the scope of the Connect Project, reports an open schooling initiative that was developed at the Senhor do Bonfim State College (CESB) and involved subjects in the area of Science and Mathematics, having as participants in the action students of basic education, guided by the teachers of the Senhor do Bonfim State College (CESB): Maria Celeste Souza de Castro, Robson Souza, Fabiana M. Esteves, Keitiane da Costa Pimenta and Vanilton Miranda Nunes . In partnership with the State University of Bahia (UNEB), through the Research Group on Management, Education, Science and Technologies for Social Inclusion (GEC & TIS), part of the Multidisciplinary and Multi-Institutional Graduate Program in Knowledge Dissemination (PPGDC) and the Green School Program (PEV) of the Federal University of Vale do São Francisco (UNIVASF-Petrolina).

1. INTRODUCTION:

The meaning of this partnership was the implementation of open schooling, applying the Care-Know-Do methodology, from Connect, articulated with the doctoral research of Professor Maria Celeste Souza de Castro, under the guidance of Professor Silvar Ferreira Ribeiro, who sought to develop collaborative actions in which it was possible to expand the universe of references of students from a scientific look at the reality in which they are inserted. using the language of science and mathematics to critically understand their context, increasing their scientific capital. With this intent, a CESB Collaboration Network (RC) was built in which there was integration and mutual help of the following actors: teachers and students of the 2nd Teaching classes of CESB, students of the degrees in Mathematics and Physics and researchers of GEC&TIS.

Assuming the principle of inseparability and interdisciplinarity, the students involved were encouraged to use the contents worked on in the disciplines to 'look' critically at the context in which they were inserted, to build a formative path based on their identification with the themes worked on and to produce material and disseminate knowledge to their communities.

2. PROJECT IMPLEMENTATION

The studies were carried out based on the challenges of the students' reality in which **the pillars of CONNECT** subsidized the actions. The pillars adopted were **OPEN SCHOOLING**, due to the idea that the expansion of the study of disciplinary contents based on the exploration of its own context would enable a more interactive and flexible learning environment; **SCIENCE-ACTION**, considering that the themes IAV-Neighborhood and Arbovirores- 'Aedes in focus' were worked on from the perspective that students could disseminate the knowledge acquired through the awareness of their families and the community of their neighborhood.

Figure 01: Project implementation

2.1. C.

For each theme, a question has been constructed.

For the Theme, (IAV) - Neighborhood: What is the Green Area Index (IAV) of my neighborhood? What is the importance of maintaining green areas in the neighborhood? And what Public Policy can we suggest to the rulers of our city?

For the theme: Environment and health – the arboviruses "Aedes in focus", the question: What environmental awareness do students, their families and friends in the neighborhood have regarding the care of the environment to prevent the proliferation of the Aedes mosquito? What can be done to increase environmental awareness in your community?

Figure 02: Data Survey

Figura: 2

The methodological steps that support the CONNECT (Care-Know-Do) proposal were used. In an interdisciplinary action, the themes, environment and health, transversalized the discussions of the following disciplines: Mathematics, Physics, Chemistry, Biology and Scientific Initiation (CI). The stage of work with the contents, conservation of fauna and flora, impact of environmental degradation and low green area index (IAV) on the proliferation of mosquitoes; care for the environment -

afforestation and sanitation culminated with the study, in the discipline of Mathematics, with the study of Areas, connection with Green Areas (TOLEDO; MAZZEI AND SANTOS, 2009); function study, making a connection with the theme conscious consumption of water (BONJORNO, et. Al. 2020) and the contents of Statistics to study the arboviruses of 'my neighborhood' in a proposition of knowing, intervening and disseminating.

Students from the 2nd High School/Integral School were involved in the actions, totaling 97 students. Of the community actions, seven neighborhoods were affected, considered as neighborhoods that have social vulnerability.

2.2.KNOW STAGE

In the "Aedes in Focus" Project, the areas of Natural Sciences and Mathematics were involved.

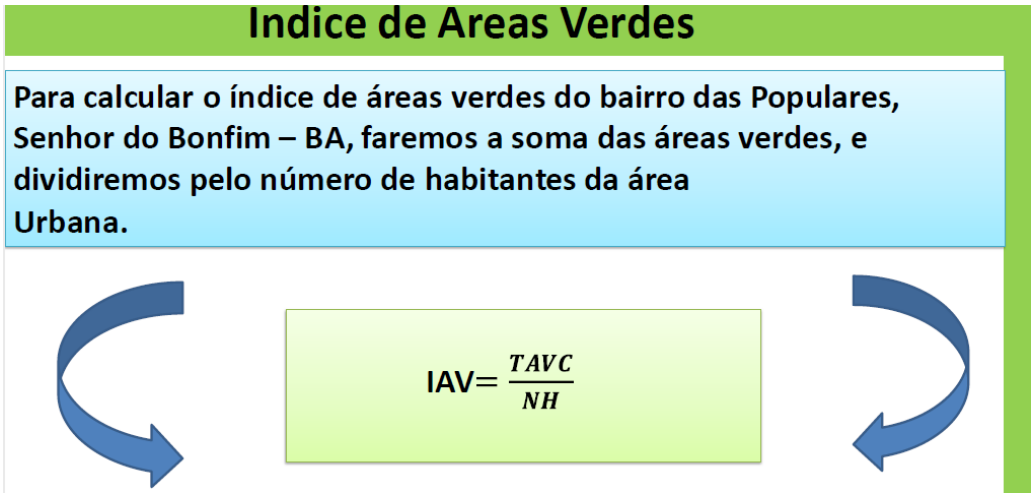

Figure 03: Use of mathematics to calculate the green area index

In mathematics, the contents of Statistics were studied, seeking to enable students to critically interpret the environmental situations in their communities, through the analysis of the graphs. We understand that this action developed the competence to use mathematical language to build consistent argumentation and present proposals to the community using collected data. In chemistry, the students worked on the following guiding questions: the use of insecticides (the smoke cars), the damage caused to the environment. In the Scientific Initiation (CI) course,

students were encouraged to build hypotheses, study objectives, data collection and compilation.

In the Green Areas Index (IAV)-Bairro Project, the content worked on was Geometry: Areas and Perimeter. Using Google Earth tools to capture photos and the cell phone itself to take photos of the neighbourhood, of Excel for the organization of the collected data and of the textbook for the study of the content. From these, Power Point presentations and videos were produced.

Figure 04: Students using Google Earth tools

The results of the work were exhibited in the classroom, through oral presentations and in the final action of the Unit, with dissemination on the murals of the schoolyard.

2.3.DO STAGE

At the end, the students prepared videos, a promotional card and posters. With the encouragement of developing collaborative actions, the high school/full-time students worked together with the students of the universities involved - UNEB and UNIVASF - Petrolina - PEV Project. The video, produced by student Felipe Rodrigues da Silva, presented data about the neighborhood in which he lives and reflected on the need for Public Policies for the conservation and expansion of green areas. This work was built collectively among colleagues and with the help of the resident of the neighborhood Mr. Jailson Araújo Presentations were also built, using the Power Point resource, as shown below.

Figure 05: Poster

3. FINDINGS RELATED TO THE OPEN EDUCATION APPROACH

The pillars of CONNECT: OPEN SCHOOLING and SCIENCE-ACTION allowed all those involved to develop their actions in a flexible way (the action was developed without charging for embedded results) in which each teacher could follow a methodology that resulted in the binomial SCIENCE-ACTION, that is, to bring together the scientific concepts, worked on the contents, and action in their reality (spreading knowledge and information). It is also worth noting that the students of the school were

protagonists in their actions. We can consider that working with this idea is challenging because it takes us out of the 'boxes' and puts us in front of a greater involvement with the social issues of these students. "This science action was selected by the government of Bahia because it is relevant to the population of the state. The mapping of green areas as a law to be discussed and approved will benefit the entire region in the area of health and environment. In addition, in the educational area, the law will facilitate public education policies also because this initiative was the result of the CARE-KNOW-DO open schooling of the CONNECT project supported by UNEB

This model can be promising in implementing the idea of "Comprehensive School" in a format that breaks with the idea of componnets distributed in one school day.

4. STUDENT RESULTS

The students produced promotional material, built texts with reflections on the themes and solved questions with the themes and contents studied. I understand that there was a greater involvement of the students during the period in which the projects were being developed

At the end of the school year, the students of the 2nd B reflected on the motivation they had to study mathematics subjects thinking about the issues of their own lives and their living spaces.

Figure 06: The student Jessica Liborio was one of the 63 young people selected to attend the deputy/senate event for discussion of the new public law "mapping green areas" which was a rpoject developed with the CONNECT open schooling CARE-KNOW-DO approach.

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Open Schooling in the Sustainable Development Reserve of Tupé Amazon rainforest.

DOI: 10.5281/zenodo.10200311

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Abstract: The objective of this study is to promote reflexive discussions among students, researchers, and local communities to collectively protect life in Amazon rainforest. The study presents open schooling activities that learners and community members of Tupé a sustainable Development Reserve located in Amazon developed with researchers from UFAM University and the CONNECT Project. One of the results of this studies is a map about questions that we discussed which will enable to continue the discussion and develop new studies.

5. INTRODUCTION:

This study is based on the open schooling activities in one of the six communities of the Tupé sustainable development reserve, on the banks of the Negro River, located in the countryside 25 km as the crow flies from the city of Manaus in the state of Amazonas, Brazil.

The Tupé region, a rural area in the municipality of Manaus, is one of the territories affected by climate change, both in terms of worsening droughts and floods, exacerbating socio-economic and environmental challenges.

According to studies by Borges, Silva and Muller (2021), the community experiences many difficulties in relation to public policies, since there is a lack of public sanitation, health centres and public transportation.

The citizens have a low income and survive on small-scale farming, fishing, tourism, and commerce. The Sustainable Development Reserve's education system is supported by three types of learning: informal, which refers to the appreciation of local and community knowledge, present in the Amazonian way of life; non-formal, which relates to community projects, organized by external or internal agents and which has an organized cycle and objectives; and formal education linked to the systematized knowledge of the school and its regular training. This triad of the training process enables different critical contexts in which communities come to recognize their place in protecting the culture and heritage of traditional communities.

This report investigates the factors affecting the livelihoods of the São João do Tupé community.

By highlighting the opinions of young people and adults in the community, through open schooling for responsible citizenship our research presents a vivid collective picture of the climate disruptions affecting the community.

In order to intervene, it is necessary to invest in education and reflect, research, and innovate collectively using the basis of responsible research and innovation.

6. PROCEDURES

Open schooling was introduced as a set of learning activities to discuss problems that are important for our community and includes students from different ages – children and teenagers, teachers, as well people of our community and from the universities who work with research.

The activities that we developed were based on the model CARE-KNOW-DO which is a way to make learning more useful and connected to the things that we care about, and we want to know more about and also do something about.

The discussion encourages all members to be involved in problem-solving and research about the subject. So what we learn matches with what students we are interested in and need to know to take actions. In our understanding

- CARE: This is about learning informally from professionals and family members. It helps students connect with real-life problems and issues that matter to them.
- KNOW: This is about learn new things and involves also learn how to research to find answers with sources and people. It's like studying and discussing facts and information to increase our understanding with different opinions.
- DO: This is about taking action, making decisions or do something practical based on what we have learned.

7. ABOUT TUPÉ COMMUNITY

The Tupé Sustainable Development Reserve in the Amazon is like a special place where we protect nature and make life better for the people who live there.

1. People who have lived here for a long time use the land and trees to survive, and we also taking care of the environment.
2. Visitors can only get to this place by traveling on the Negro River. It takes about 30 minutes to 1.5 hours to get there from a city called Manaus.
3. It's easier to move around in boats when it's rainy (January to May), but it's harder during the dry season (June to October).
4. We really care about the people who live there, their culture, and the forests and rivers.
5. In the Amazon, there are lots of different groups of indigenous people with their own languages, cultures, and traditions. Some you might have heard of, like the Yanomami, Kayapó, Tikuna, and Munduruku. But there are also smaller groups, like the Tuyuka and Dessana, who are part of Tupé.
6. The local people also use their culture to welcome tourists. They dance, sing, and make things like musical instruments, bracelets, necklaces, and headdresses to share with visitors. This helps people make money to support their families.

   So, in simple words, Tupé is a special place where people live in harmony with nature, protect their culture, and welcome tourists to learn and appreciate nature with us.

8. DISCUSSION AND RESULTS

Participants worked in small groups and also shared their views with everyone too, with discussions and drawings. The conversation was mapped including the questions.

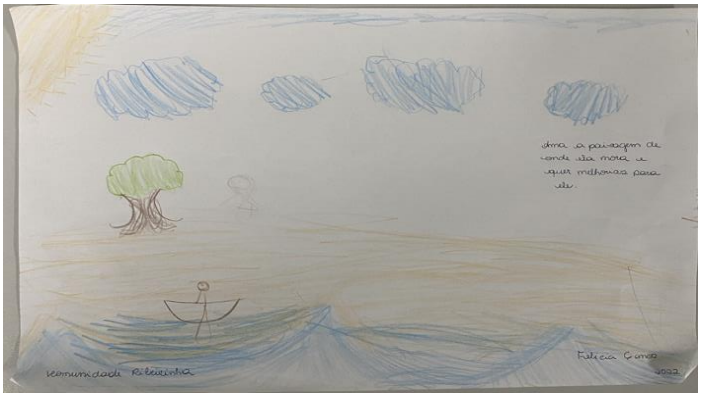

Figure 1 - Drawing using paper

Figure 2 - Drawing using tablet

These are some of the views that partcipants shared in groups, drawing and writing.

> "*I wish that we had a house and boat." boy*
>
> *I love the landscape where I live, and I want to see improvements for my riverside community*". girl

“What I ask for the community is that we be strong, in the sense of union, of wanting, of having the will to join and do things. Because when we really want it, we do it”. A community member grandmother

Thinking about the Amazon means considering its diverse social and cultural contexts, in which the sustainability debate should generate valuable insights for local communities regarding the integration of economic, social, cultural, and environmental dimensions." - Amazonian academic researcher.

What participants learned:

1. *We learned what open schooling means and how it works.*
2. *We found out about new ways to work together to discuss problems, like using research maps, drawing, thinking and talking.*
3. *We got better at understanding problems and figuring out how to search for possibilties with these new ideas.*

These are the questions that participants mapped supported by researchers.

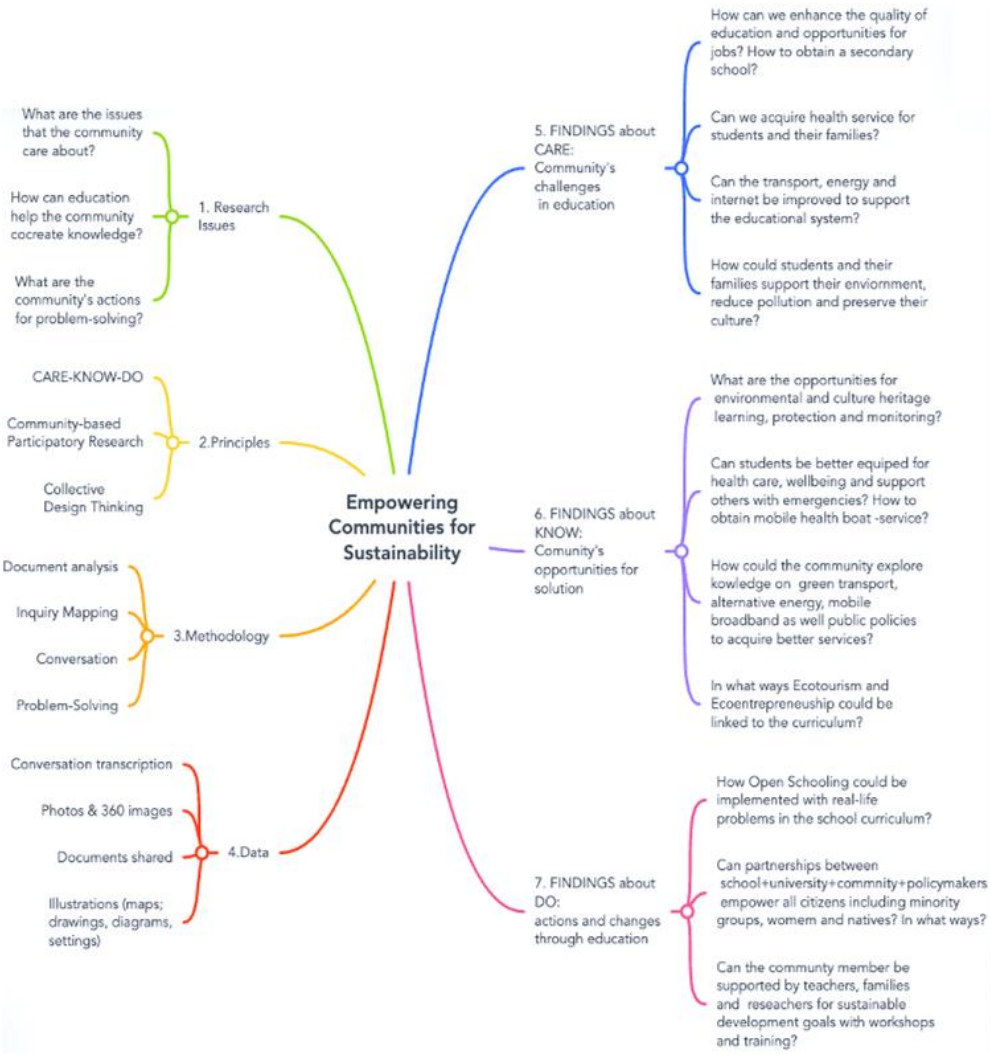

Figure 3 –Inquiry Mapping of the Community supported by the researchers

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