D6.1: Report on case studies

developed by partners, centred on particularly interesting SSIBL-CoP implementations in their countries during Round 1 and 2

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Contents

Glossary

Alma Löv	Museum of Unexp. Art
BBC	Beit Berl College
COSMOS	Creating Organisational Structures for Meaningful science education through Open Schooling for all
CORPOS	Core ORganisational Structure for Promoting Open Schooling
CoP	Community of Practice
HEI	Higher Education Institution
IE-UL	Instituto de Educação da Universidade de Lisboa
KdG	Karel De Grote Hogeschool katholieke hogeschool
KU	Karlstad University
MoE	Ministry of Education
SDG	Sustainable Development Goals
SSI	Socio-Scientific Issue
SSIBL	Socio-Scientific Inquiry-Based Learning
SOTON	University of Southampton
STEM	Science Technology Engineering Mathematics
TPD	Teacher Professional Development
UU	Utrecht University
WP	Work Package
WSC	Winchester Science Centre

1. Overview of Deliverable 6.1

This report presents a comprehensive analysis of multiple case studies that document the implementation of the COSMOS project across various educational landscapes in Europe and the Middle East. The COSMOS initiative seeks to transform traditional educational settings into dynamic, open learning environments where students, teachers, societal partners, and communities collaborate to address socio-scientific issues (SSIs). Utilising the Socio-Scientific Inquiry-Based Learning (SSIBL) framework, COSMOS emphasises the development of inquiry-based, action-oriented learning processes that connect scientific education with real-world problems, fostering both academic knowledge and social responsibility.

The case studies included in this report cover implementations in six countries: Sweden, Portugal, Belgium, Israel, The Netherlands, and the United Kingdom. Each context reveals unique applications of the COSMOS model, tailored to the specific cultural, social, and educational needs of the region. The different examples reflect the flexibility and adaptability of the COSMOS model to different socio-educational realities.

Central to the success of these implementations is the formation of Communities of Practice (CoPs) and the establishment of CORPOS (Collaborative Open Schooling Partnerships). CoPs bring together various actors—teachers, students, researchers, societal partners, and often local government or business representatives—to co-design and implement inquiry-based educational activities. These communities are vital in supporting ongoing professional development for teachers and fostering meaningful collaboration between schools and their surrounding communities.

The report highlights both the successes and challenges encountered during the implementation of COSMOS in each country. Common successes include increased student engagement, the development of critical thinking and problem-solving skills, and stronger connections between schools and communities. The implemented activities not only fostered scientific literacy but also empowered students to take action within their communities, embodying the SSIBL approach's commitment to linking knowledge with civic engagement.

However, the case studies also shed light on the challenges faced by schools and educators. Time constraints, curriculum pressures, and the need for sustained external support often presented obstacles to full implementation. Teachers in many cases, while enthusiastic about the project,

reported difficulties balancing the additional workload with their existing responsibilities. These challenges underscore the importance of institutional support and the need for long-term strategies to sustain these innovative approaches.

Through the detailed examination of these diverse cases, this report provides valuable insights into how open schooling initiatives like COSMOS can be successfully implemented in different contexts. It also offers lessons on how to overcome the barriers to fostering deeper collaboration between schools and communities. Ultimately, the report demonstrates the transformative potential of integrating socio-scientific inquiry into school curricula, equipping students not only with academic knowledge but also with the skills and agency to actively engage with and improve their societies. This work is intended to inform educators, policymakers, and community leaders interested in adopting similar open schooling approaches, offering a roadmap for creating meaningful, socially connected educational experiences.

Each partner developed two case studies centred on particularly interesting COSMOS implementations in their country, one during Round 1 (Milestone 3) and another during Round 2 (Milestone 5). These case studies (organised according to a common structure/guide) assured access to knowledge/expertise produced during the development of different open schooling processes (organisational structures and cultures, openness levels of schools, experienced difficulties, obstacles, possible solutions, different processes, etc.). This set of case studies is meant to inform the roadmap development.

2. The Case Studies of Round 1

Each partner developed one case study during implementation Round 1, centred on a particularly interesting COSMOS implementation in their country. The case study was focused on the progression of a Community of Practice (CoP), beginning with the context in which it was proposed and describing the different phases of its development. It was presented as a narrative or story rather than as a list of points. The list of topics included in the guidelines served as a set of points to be addressed within the narrative, ensuring that each case study covered the same topics of interest. Each country's COSMOS team prepared the case study using information collected through the already implemented focus group and individual teacher interviews.

According with the provided guidelines each case study mentioned several key topics. First, it addressed CORPOS, describing the characteristics of the CORPOS that acted as a catalyst for the Community of Practice (CoP). This included details about its members, their roles, how it was created, and how it functioned, along with its strengths, weaknesses, obstacles, and difficulties in functioning. The strategies developed to overcome these challenges were also discussed, as well as the perceived impacts of CORPOS on the school's openness.

Regarding the Community of Practice (CoP), the case study explained the reasons for choosing this CoP as the focus and provided contextual information about its development, particularly details about the school, such as its sociocultural context and openness dimensions (which included shared governance, curriculum, inner school communities, learning communities, student participation, parent involvement, social engagement, and community collaboration). The creation of the CoP and its relationship with CORPOS were outlined, along with the various stakeholders involved, their roles, and levels of involvement.

The case study also examined the CoP's purpose, specifically the Socio-Scientific Issue (SSI) it focused on and the reasons for choosing it. It described how the CoP functioned throughout its lifetime, from establishing the SSI that became the focus of learning, to developing and implementing the learning unit. Additionally, the initiatives developed by CoP members were detailed, particularly the SSIBL (Socio-Scientific Inquiry-Based Learning) implementation and the various activities that took place in each phase (ASK, FIND OUT , ACT).

Each case study also covered the reactions of different participants to SSIBL, the difficulties encountered during its implementation, and the strategies developed to address those difficulties. It highlighted the opportunities created by the CoP, its strengths, key success factors, and the weaknesses, obstacles, and difficulties in its functioning, along with the strategies developed to overcome them.

Finally, each narrative examined the impact of the CoP, discussing the perceived effects on the school's openness, teachers' professional development, student learning, and other participants' learning. It also included the perspectives of different participants on the relevance and interest of the CoP and its initiatives, supported by evidence. It concluded with an overall balance, offering final reflective remarks.

2.1. The case study from Belgium

Novaplus – a school where kids come to learn STEM

Novaplus is a modern, young school in the metropolitan city of Antwerp. Novaplus is a secondary school where STEM is at the heart of everything that happens. Here, students' wildest STEM dreams come true: in modern labs and classrooms, students can experiment, study and communicate actively about their work. Novaplus want students to feel happy and productive member of the school's community. Through a collaborative teaching approach and extensive students' participation, students learn how to work with feedback and optimise their own learning.

The school is located in a multicultural part of Antwerp. With its 500.000 inhabitant and 172 nationalities, Antwerp ranks as largest and the most diverse metropole in Flanders (the Dutch speaking community of Belgium). Students at Novaplus are not there by accident, together with their parents they have made a very conscious choice for this specific STEM school. It is the schools' overall mission, STEM vision and inquiry based pedagogical approach, that attract students from throughout and beyond the city of Antwerp. Consequently, these students, and by extension the school as a whole, are often unfamiliar with and unconnected to the local neighborhood. For the school this is the challenge they want to tackle heads on, something they hope the SSIBL-CoP approach of COSMOS can contribute to.

The Novaplus CORPOS – 1+1=3

Within the COSMOS project the CORPOS of the school consists of the two year 3 STEM teachers, one school policy coordinator, and the school leader, two pedagogical advisors from the educational

organisation Djapo and three teacher trainers and researchers from Karel de Grote University of Applied Sciences and Arts (KdG).

In line with the challenge identified above, the CORPOS pinpointed two of the eight COSMOS openness dimensions as the bigger picture for implementing SSIBL-CoP: more (and more meaningful) social engagement and community collaborations. Throughout the school year, regular coaching session were scheduled to keep the project on the map and not let it get lost in the rush of the daily reality that exists in every school. Nevertheless, we note that forming and sustaining the CORPOS was challenging and specific attention and continued effort from all partners are crucial to pull learning as a community, and the role of the CORPOS within that, into the day to day reality of the school.

Community of Practice – getting the police involved

The initiation of the Community of Practice, started from an already existing consultation structure of the 'teachers project STEM year 3' – the two year 3 teachers of the CORPOS, Djapo and KdG. As an SSI, it was jointly decided to focus on liveability and problems around the local neighbourhood (specifically the large park within which the school is located). Within the CORPOS, it were the teachers who then identified local law enforcement as a valuable partner to include into the Community of Practice.

During the design of the SSIBL-CoP, we worked in different concrete steps: intake – kick-off – workshop – consultations – reflection & evaluation. The theoretical input we provided to the schools was the following: SSIBL-CoP, didactics to explore, investigate and take action on socio-scientific issues. Collaboration with the teachers was strongly based on the needs of the team. Coaching moments were planned on in advance for the whole year to avoid practical difficulties. Only when the team had important questions or needs at that time, were the coaching moments filled in.

SSIBL implementations

At the start of the process of designing the SSIBL-CoP, the officers from the local law enforcement clustered what they experience as of the main issues they face in the vicinity of the school district. Across a 7-week project (2 hours a week), students were then given the opportunity to work an issue of their choice from this list. Students from the two participating classes explored at first the reported problems, went for a walk around the neighbourhood and then choose one topic per class. One class got to work on homelessness issues in the park next to the school, the other wanted to focus on e-bikes that race through the park.

ASK

In this phase, the students explored their SSIs (homelessness and mobility in the park). Through different work forms offered by Djapo - e.g. Cheese with holes, the Problem tree, Back casting,... -, they made their own thinking visible. These thinking tools helped the students to explore, compare and make choices about parts and wholes to focus on in the following steps of the project.

FIND OUT

To answer the chosen focus, the students conducted neighbourhood investigations. At first, they consider the following topics:

- What questions do we want to investigate?;
- In what ways can we obtain answers? (interviews, surveys, talking to organisations,...);
- Start drafting questionnaire with a clear goal in mind;
- Contact the organisations (by phone, via mail).

Then came the actual implementation of the finding out, with different target groups: the homeless people, users of e-bikes, the neighbours of the school, the homeless organisations, the police & city custody, the passers-by in the parc. The students themselves determined the different stakeholders that they addressed during the neighbourhood investigation. At the end, they shared the results with each other to come to a common overview and understanding of the issues at play within the SSIs.

ACT

Within each class, smaller groups of students chose a specific part of the SSI to address through designing solutions and prototyping these as much as possible. Students presented the different solutions to officers of the local law enforcement, who provided feedback to help them to answer such questions in the future in another, more meaningful way. Some of the insights from the students actually made it into new policies and practices in and around the school, as an example law enforcement updated that policy around mobility in the park and installed new signs in which the input from the students was used.

Reflections on this case

The high level of meaningful student participation proved to be a success factor in the Novaplus Case. As was the fact that the project's focus and inquiry activities - with which the students of this school are familiar - was linked to social issues.

During implementation, it turned out that gaining experience starting from SSIs and involving the school environment was experienced both as innovative and challenging for the school team. The enormous workload and periods from the involved teachers hindered making steps towards a more sustainable CORPOS. The teachers of Novaplus were positive and enthusiastic at the beginning of this project. But during the different steps of the process, they were often hesitant to participate. They indicated more need for clear expectations both for themselves and for the partners of the project. At the end of the process, however, they were positive and enthusiastic about the final result.

A success factor of the Community of Practice was the ownership of the project with the students that always remained with the teachers themselves. In this way, we also achieved the highest levels of participation where the teachers made and organised decisions entirely by themselves. Djapo and KdG acted as facilitators, providing new insights or asked critical questions.

2.2. The case study from Israel

Elzahara primary school, Israel

Elzahara school is a primary school in the (Arab) town of Tira situated in the Sharon Region of Israel and is associated with the central district of the Ministry of Education. The school caters to 482 students (260 boys and 222 girls) from grades one to six, with a staff of 34 teachers (1 male). Grades 4–6 participated in the project. In each cohort there are 3 classrooms and 1 special education classroom. In the fourth grade there are 70 students and in grades 5 and 6, 75 students each. All together 220 students participated in the project.

The school was selected to participate in the COSMOS project via an open call recruitment process. From dozens of responses, a handful of schools were selected, with whom the COSMOS team (HEI and societal partners) conducted two communication events (the first- long distance and the second – face-to-face). In these events, the COSMOS team introduced the basic approach and concepts of the project, and the schools began thinking about which teachers will participate in the project and what kinds of social-scientific issues they were considering investigating. The Elzahara school was selected to participate in round 1 based on the enthusiasm of their team, the dedicated leadership of the school principal and the initial acknowledgement of how participation in the project contributes to the school and its community.

The CORPOS

Once the school was selected, representatives of the school were asked to determine which school staff would be present in the first meeting with the COSMOS project team. The external (HEI and societal partners) and internal (school) members that were present in this meeting constituted the initial CORPOS. This included two Higher Education COSMOS partners and representative of the MoE (social partner), and five [internal] school staff: the school principal, pedagogical coordinator (also science teacher), language teacher who is part of the school management team and two science teachers, one who serves as the COSMOS coordinator. It is noted that the internal CORPOS members were present at all the TPD sessions and were actively involved as CoP members in the round one implementation. This is one indication of the commitment of this school to enabling deep change in the school organisational culture.

The first TPD meeting focused on revisiting the overall aims and core concepts of COSMOS, directing the participating teachers to discuss these in the context of the school and in relation to themselves and their roles in the school. This discussion aimed at “recruiting” the teachers to the project, addressing the teachers' identity in relation to COSMOS and gaining their support. This meeting with the school CORPOS team also included the [pre]focus group discussion on school openness dimensions and how they are implemented in school. In this animated discussion, the school CORPOS identified several attributes regarding the school. Some of the main insights identified from analysis of the focus group were that: there is 'in-between' openness in shared governance (the teachers have autonomy in the classroom regarding its management) and the curriculum. They identify themselves outward in 'social engagement', with much investment in promoting community needs including student volunteering. Their outward openness in social engagement translates into in-between

openness in 'community collaborations'. The school identifies itself outward in 'parental involvement' – parents influence both policy and pedagogy of the school, there is ongoing fruitful dialogue between the parents around issues in the community agenda, the parent committee is active and meets regularly, ang the school maintains two parental committees – school and classroom. Regarding 'student participation' and 'learning communities', the school identifies itself in-between – subject teacher teams work together on a regular basis, the student council is active. On the whole, the CORPOS members felt that there is much room for moving outward on many of the openness dimensions.

The SSI

Since the aim in Elzahara was to connect the project and the SSI selected for investigation to as many school subjects as possible, the CORPOS team included science teachers, a language teacher, and teachers acting in various roles in the school. Following the school recruitment (open call) process, the school entered the project with an initial SSI – 'coping with stress'. TPD meetings conducted with the COSMOS team, addressing key concepts of COSMOS is relation to the school, led the school CORPOS members to rethinking the SSI. Focusing on COSMOS concepts helped them understand that they need to make the SSI more relevant to the local community and enable the involvement of more diverse community members, as well as align with learning science. This led the school team to selecting: 'promoting healthy lifestyles in our community' as the SSI for study. This was an important stepping stone in the developing the COSMOS mindset (and open schooling): in this rethinking, the Elzahara CORPOS members exhibited flexibility and were open to re-assessing their initial SSI and change their focus to address an authentic community social-scientific issue given the high rates of obesity in the community and general low awareness of aspects related to healthy lifestyles. The SSI was selected as we all reached the conclusion that raising awareness and learning about healthy lifestyles can considerably address long standing problems in the community and promote community well-being, which is one of the central aims of open schooling.

In the TPD sessions, after selecting the new SSI, discussions included a mapping of the issue (a concept map) which essentially involved a stakeholder analysis to identify role players in the town (different positions held in the town) who are relevant to the issue as potential CoP members. The aim was to include as many stakeholders as possible so that the school community would benefit from the process. The CORPOS members also addressed questions such as: what does being a community mean for us? What characterises a community? Where are we currently at? What is our vision of the future? What is our role in getting there and how can we get there? How can we promote learning as

a community in our specific community? What are the human resources available in our community to achieve this? Addressing these questions and identifying the human resources that are available in Tira around these, by the CORPOS team, was central in creating the CoP around the selected SSI.

The CoP

Establishing the CoP was conducted in stages: first, the principal presented the SSI and the project to the entire school staff. Then, school members were selected according to their professional expertise: the student leadership teams - from grades 5 and 6, all together 29 students - and teachers. A total of 19 teachers (including the CORPOS team) were identified for the CoP from diverse subjects, including 2 physical education teachers, 6 first and second grade teachers, 3 science teachers, and all (7) language teachers (Arabic, Hebrew, English). Parallel to identifying internal CoP members, out-of-school community members were also selected, mainly by the school principal, from the relevant stakeholder groups identified in the concept mapping. These included a range of different circles extending from internal school organisation outward toward community circles: doctors' union, an HMO nurse (community health management organisation), dieticians, a sport center, senior citizens' [retirement home. It is noteworthy that the process of identifying CoP members and establishing the CoP built on some pre-established school-community relations existing before joining the COSMOS project. There was an understanding among CORPOS members that each stakeholder identified can contribute their distinctive expertise and knowledge to the learning around the SSI. Additionally, there was an understanding that creating an atmosphere of mutual trust and cooperation was a crucial element in creating a strong community of learning. After identifying the CoP participants, the CORPOS members initiated the co-design of the implementation. The co-design included articulating critical questions (ASK), such as: What specific problems of unhealthy lifestyles do we identify (e.g., student obesity; low levels of physical activity; lack of understanding about healthy diets)? What can we do to address these specific problems? How can we promote adopting a healthy lifestyle in our community? How will a healthy lifestyle affect our community? These questions, that were articulated by the CORPOS members, led to the development of several of the learning components (FIND OUT) such as the monitoring of a group of overweight pupils, conducting classes on healthy diets, inviting grandmothers to share traditional medicine methods. These nicely exemplify SSIBL – how rich ASK sets the basis for diverse and meaningful learning (FIND OUT). An aspect for improvement is strengthening the inquiry-based learning; in this round much of the learning activities were not inquiry-based. The co-design included addressing questions regarding the contents of learning (subject-matter), which learning activities to incorporate and with whom, scheduling the implementation within

classrooms, including a peak event, contacting, and coordinating with the different CoP members and specifying where and when the different activities would take place.

The inquiry stage (FIND OUT) was conducted through a series of five lessons conducted mainly in school. Student leadership from grades 5 and 6 taught 4th graders about leading healthy lifestyles. Several classes were conducted with the school counselor, with parents, and with dieticians who shared their knowledge and experience regarding different aspects of a healthy lifestyle: healthy diets and how to lose weight, how sports and different types of physical activity can contribute to a healthy lifestyle, social connections, and the connection between health and wellbeing. Language teachers incorporated in their lessons plans texts and other resources that addressed leading a healthy lifestyle and related issues. Students, for instance, learned new vocabulary in Hebrew on names of the diet pyramid and through these new terms learned what contributes to their health. This was conducted in grade 4 and was further expanded in grades 5 and 6. This new vocabulary and the texts that were used by language teachers were then instrumental for applying scientific reasoning also in other lessons, thus providing useful knowledge for the learning of science education. A day long peak-day event, culminating the learning process was conducted, included diverse activities around the different aspects of healthy lifestyles in which diverse CoP members conducted the activities – doctor's lecture, dieticians' workshops, grandparents shared knowledge and experience around cultural traditions for maintaining health and traditional medicine, the student leadership groups gave lectures around preparing healthy diet pyramids. All the students in the school grades participated in the peak-day, thus the entire school community was involved in the different activities that took place that day. The student council, as well as the student leadership group, played a leadership role in the preparation and implementation of the peak-day, leading a community contribution session in which funds were donated toward addressing the needs of the community.

The ACT component of SSIBL is embedded in the essence of the SSI selected as the focus of learning; promoting health lifestyles specifically addresses community well-being and embodies actions that promote community well-being. Accordingly, the ACT stage was embedded in the various phases of the learning process. Action was expressed in the active engagement of the student leadership groups. The engagement of parents, grandparents, the municipality, and local health organisations in the learning process reflects actions made in the service of community well-being and promoting healthy lifestyles. More specifically, a health group was established with a group of overweight students who entered a follow-up monitoring diet plan with a dietician.

Strengths, opportunities, success factors and challenges

Several strengths can be identified in the learning process. The school principal took a meaningful leadership role in the project and was deeply engaged in the various activities (from TPD to the planning and implementation of the CoP). Her leadership, commitment, support, and encouragement had a positive impact on teachers and the learning process. The teachers participating in the project – from diverse disciplines and roles - were highly committed to the project and the SSI and were very much engaged in preparing and coordinating the various learning activities and cooperations. The community approach has a positive effect on relationships among the school staff: teachers worked together, assisted one another, and even took over other teachers' responsibilities in case of absence.

The understanding that new ways of learning and teaching, and more initiatives and creativity must be introduced into schools was widely accepted. Teachers learn to be more curious, think about learning contents, and how to change their routines. The cooperation among teachers of different disciplines (for example between language teachers and science teachers) was enhanced, contributing to the quality of learning in school. Students had greater responsibilities over the learning process and became more active. Given responsibility, they developed various skills including some scientific skills (such as monitoring data), to be innovators and contribute to others in the school and the community. Also, student leadership, particularly the student council, was found to be significant and involved in many aspects (for example, school bell, assisting students with digital skills and generally serving as a voice for students) and their general contribution to the school was even more appreciated by the teachers. Parental engagement was considerable, especially from those that actively participated in sharing their knowledge and insights with the students, and those that assisted in preparing the activities. The school community as a whole, as well as external stakeholders, were committed to the project and conducted smooth coordination among the different stakeholders. The importance of community wellbeing and the role of the school community in promoting it became clear to everyone involved.

Alongside these positive aspects, that were evident in the various stages of implementation, it became clear that coordination with external stakeholders and incorporating them into the learning process demands resources of time that are limited- more meaningful Implementation of the COSMOS method demands more resources, including working hours. While many teachers were engaged and committed to the process, some resistance was expressed by some teachers, who felt that the process disrupted school routines. Furthermore, various dilemmas surfaced regarding how to choose the student leadership team, who would participate and how, where to conduct the learning process (in

school or out of school). Another issue that arose is how to evaluate the process, and how to grade the learning process. Additionally, despite the significant learning process that took place as a CoP and with the significant involvement of both internal and external CoP members, a standing challenge is that the majority of learning was not inquiry-based. While strategies to overcome these problems that arose during the process were employed (such as ongoing clarification of the shared objectives, and emphasising a sense-of-togetherness, cooperation, and mutual support to reinforce the commitment of everyone involved around the common goal), these challenges require more work and provide some of the focuses for future ongoing development.

Another aspect of the process is the understanding of the importance of flexibility, on being continuously open to revise the way we learn and what we learn, to change roles and positions in school and not to be afraid to breach the borders of the standard curriculum. The project exposed how much students are open and curious, have a thirst for knowledge in topics that are presented to them as relevant to their lives, and if given the chance to be more active participants in the learning process. The idea of mutual learning (learning from one another) was also central to the process as well as the idea that standard evaluation through testing and rote learning needs to change. The curriculum is a constant, but it is equally important to expand the implementation of learning communities, to work more seriously on how learning communities can help the school to move beyond the usual structures and routines, to engage with the community.

The collaboration with external CORPOS members, such as the HEI partners and the MoE team was helpful in articulating the SSI and planning the process, and through discussions aided the school team in acquiring knowledge and relevant skills. The implementation process brought new understandings and learning contents that were not previously in school, instigated greater cooperation among teachers, and among teachers and students, and naturally, expanded the cooperation between the school and the community. Following implementation, the school is thinking about additional cooperations, including with neighbouring schools, looking differently at the community and who can and should be involved in learning. It promoted a different outlook on the role of school. Elements of community were always in the school, but they have been significantly expanded, and now "it has a name" - is part of school language/discourse and work is on how to extend this. This was explicitly articulated by the school principal who expressed the need to take all the elements of COSMOS further as part of the organisation culture and school policy.

2.3. The case study from The Netherlands

School context

We approached the 'Anna van Rijn college' (secondary school) through our personal network. The school was recommended by our societal partner (Universiteitsmuseum Utrecht).

The school is located in a city near one of the major cities in The Netherlands. The population of students is diverse. Local youth workers have an office in the school and mingle with the students during breaks. Students of a specific year grade perform social service work for several weeks at organisations in the neighbourhood. Another year layer participated in a clean-up-the-community activity. During the schoolyear there are two special weeks ('ANNA weeks') when the regular timetable is abandoned to organise more easily open schooling activities.

Specific curriculum related activities are organised by individual teachers, such as in science classes guest lecturers or lessons from national organisations on student health topics (alcohol & drugs). Moreover, individual STEM teachers organise activities for students outside the school, such as an observatory or a local nature or environment organisation.

The curriculum-related collaborations are considered fragile and not very sustainable because they depend on enthusiastic individuals from the school and the organisation. There are plans to make these collaborations more sustainable by 'gathering' them into a committee which documents these collaborations and appointments.

Although, the science teachers feel freedom to organise open schooling activities, the teachers in upper-secondary classes feel pressure to spend 'all' their teaching time on core topics and skills assessed in the national exams, as exam results last year were disappointing.

The CORPOS

At the start of the school year the HEI partner organised a CORPOS foundation meeting which was attend by several science teachers from different science subjects. In this meeting, the objectives, processes of the project and possible SSIs were discussed. After this meeting, four teachers were enthusiastic to participate in the program. One of them went on leave after the CORPOS foundation meeting, meaning that we worked with three teachers from three different science subjects in this school for most of the year. The notion of different natural sciences is important as the teachers work with colleagues teaching the same subject, so they need to discuss their new ideas and plans with these colleagues.

The teachers insisted that they did not appreciate a member of the school board to participate in the project. They had no need for this and otherwise felt controlled or at least less autonomous. Our CORPOS therefore initially consisted of three teachers from different sciences (biology, physics and chemistry) and two staff members of the HEI partners.

In this first year the CORPOS acted as a learning community. HEI partners learned about the complexity of having ambitions as a science teacher and the daily urgencies, and unexpected events in combination with the pressure of good exam results that can get in the way of these ideals or the willingness to change teachers' routines.

In terms of the Openness Wheel, the dimensions the teachers chose to work on during the two years were 'Social engagement' and 'Community collaborations'.

Implementing SSIBL

Within this CORPOS, ,the HEI members organised TPD-workshops to get the teachers acquainted with SSIs, SSIBL pedagogy, ways to implement SSIBL in the curriculum, and possible learning and teaching activities. To help teachers design and plan their lesson structure, we designed worksheets (including ASK, FIND OUT, ACT stages) . A recurrent theme during the meeting was the role that societal partners can play and discussing possible partners. A crucial element of the meetings was the peer feedback, teachers gave feedback on the designs of the other teachers. The HEI partners were physically present at the school to give feedback too on the lesson plans, offer ideas on how the chosen SSI and the different SSIBL steps could be implemented in their lessons, and observe the lessons. The teachers were the ones who developed the lessons and taught the lessons.

The strength of this CORPOS was mainly the teachers' enthusiasm and content knowledge. They were very open and eager to learn about ways to implement SSIBL in their teaching. However, teachers struggle with not having enough time. This time constraint is present in two ways. First, when they are working on the COSMOS project designing their lesson, it had to take place after school hours, which gave them a feeling of extra workload Second, when trying to implement the designed lesson in their curriculum, the teachers perceived it as already overloaded. This led to only one of the three teachers, teaching in lower secondary education with no strict curriculum, implementing the co-designed lessons this school year. Involving external partners during the development process or live in the classes was also a step too far for the teachers due to previously mentioned aspects. Changing their

lessons according to SSIBL pedagogy, which takes more time, linking it to the curriculum and scheduling it in the regular timetable was already challenging.

Reflection on the CORPOS

Beside the CORPOS characteristics of a learning community, processes were discussed and evaluated. As HEI partners, we talked about the above-mentioned difficulties with the teachers, after which they agreed to involve the school management in the following year. After a short introduction in the first month of the new school year, a longer meeting with the school board was arranged in the second month of the second schoolyear, in which we explained the purpose of the COSMOS project and discussed ways in which the school board could facilitate this project in the school.

For this second year, we as a CORPOS have made three changes from the first year:

1. We asked that the CORPOS meetings were scheduled in the school's agenda. This means that they are visible for both the teachers and the school board. That way, the teachers are always available during these scheduled meetings.
2. We arranged weekly opportunities for (online) one-on-one moments between HEI partners and individual teachers, which can be used for feedback on lesson plans, co-design sessions or other support.
3. As the teachers of the various CoP's did not always send their renewed materials or lesson plans to the HEI partners, we now installed a shared maps on One Drive.
4. For each teacher we found a way to implement SSIBL lessons in a way the teacher thought was feasible. So, for two teachers w planned two different larger projects in 'the ANNA (activity) weeks'. These are weeks in which the school solely plans activities, and no regular lessons are taught. Planning projects in this week ensures that the teachers feel less pressure on their regular curriculum. Another teacher planned three SSIBL lessons on three different topics during the year. One of the teachers also planned a 14 weeks SSIBL lesson series on a topic in a science course which does not have a national curriculum.

Since 2022 the school presents itself more clearly as a so-called Global school, aiming at students learn in and for society. The new logo states: Open your world! The science teachers in the COSMOS project want to concretise and link this goal more directly to their science lessons, so they want to work on the dimension: Social Engagement.

SSIBL-CoP implementation

At the school three CoP's were developed. We left the choice for both the SSIs and possible stakeholders with the teachers, since they wanted to link the SSI to the formal curriculum. The topics around which CoP's were formed were: 'return of the wolves in The Netherlands', 'nitrogen crisis' and 'particulate matter' (air pollution).

The CoP on particulate matter emission (air pollution) is selected for further analysis in this Case Study as it is the only CoP from which we gathered research data by student surveys and a teacher interview.

The teacher and HEI partner involved in this CoP were both part of the CORPOS. There was no direct contact with the stakeholders involved. The stakeholders are the scientists from RIVM (Dutch institute for public health and the environment) and the government of the district Utrecht, which use the data that students gather. An intermediate organisation called GLOBE intervened between scientists and the schools around 'the globe'. Videoclips in which scientists explain the topic and project are present at the GLOBE website. It is a long-term citizen science project.

We organised three co-design sessions of 1,5–2 hours to work on lesson plans during January-April 2023. During the first meeting, we discussed possible SSIs and reviewed various SSIBL teaching and learning activities to address these SSIs (training workshop SSIBL). During the second meeting, we focused on possible stakeholders, and we let the teachers design a lesson plan focusing on the SSI of their choice. In the end, the teacher only incorporated learning activities for students to inquire different stakeholders but not involved external partners in the lesson plan. During a third meeting, the teachers were able to continue work on their lesson plan, while also working out a timeline for the implementation of their lesson plan.

The teacher who taught the lesson was not at all familiar with teaching activities fostering personal opinions or moral dilemmas with students. The teacher did use one of the SSIBL teaching activities we discussed to introduce an SSI: Arguments in motion ('*beweegredeneren*') in which students literally position themselves in the classroom in relation to a dilemma. In this case it was on whether to shut down the inner city for motorised vehicles (to minimise the particulate matter emission). The students discussed it and rethought their original position. Thereafter, students did research on this SSI. The students had to formulate and research their own research question about particulate matter. Research questions involved differences in the amount of particulate matter in different neighbourhoods. Students used specific devices that they mounted on their bicycles to measure the

amount of particulate matter in the air while driving through different neighbourhoods (FIND OUT phase). They used the measurements to answer their research question and presented their findings on a poster. The ACT phase was not present in these lesson series. The data that the students collected was uploaded to the RIVM (Dutch institute for public health and the environment).

Reflection on implementation

The second year, the teacher wants to do it the same way to less 'excellent' classes. Thus, we can conclude that although small steps are made in introducing the ASK and FIND OUT phase in the class, the teacher has become more confident and recognises the usefulness of the approach. For the second year the ambition for the teacher is to bring a stakeholder into the school. And for the HEI partners to stimulate to implement that students reflect on their initial ideas in relation to the dilemma after the FIND OUT phase and formulate an 'Enact' activity (ACT).

The teachers of all CoP's were especially enthusiastic about 'Arguments in motion' as a teaching activity. They intended to incorporate this way of dealing with SSIs more often into their teaching. The students were enthused by this activity, actively participated, shared their point of view and discussed ideas, opinions and consequences for involved parties. They indicated that the teacher did not normally use this type of activities but that it had motivated them and allowed them to get involved and exchange views with each other.

The teacher wants to implement the new lessons for all classes in the year layer. The other teacher of these classes sees the advantages of the approach, however regards the programme overloaded, and wants it implemented in a so-called ANNA week (activity week), during a day with preparation the classes before the ANNA week, which happened.

The CoP has built teacher confidence to lead teaching activities that require students to come out from behind their desks and take position in the classroom. Teachers teaching the same type of classes are likely to be introduced to the new approach by their colleagues and not by an external HEI partner. The teacher appreciated that the HEI partner planned working sessions in advance. The teacher usually developsnew materials last minute and always too late for all the ambitions and dreams the teacher had the previous year. The teacher appreciated the ideas the HEI partners had during the one-to-one sessions.

As the SSIBL approach fosters more learning goals on social and personal inquiry than the usual lessons of the science teachers, it takes more time. Time appears to be a boundary condition: time to develop lessons, time in the schedule to do it together in co-creation sessions, time to cover the curriculum sufficiently.

Reflective remarks

After one year the perceived impact of one CoP on the Openness dimensions for the whole school is not visible.

Coming year another teacher from the school (re)joins the CORPOS. This teacher is also a student teacher for teaching in upper-secondary schools and has explained SSIBL to her teacher trainer. The teacher is allowed to design and research a learning path for SSIBL & open schooling for her students. In this way we also disseminate to projects goals and results to the teacher training.

This is a case study, however there are a few aspects in science teachers' attitude that they the school involved in COSMOS have in common.

1. The teachers regard the science upper secondary school curricula overloaded.
2. The teachers want full autonomy and ownership, thus don't see need for or want a schoolboard member in the CORPOS.
3. The teachers acknowledge that the schoolboard supports 'COSMOS' goals on science and open schooling, at the same time they feel more accountable by the same school board for exam results with do not address these goals.

2.4. The case study from Portugal

The Context

In Portugal, schools are organised in clusters: groups of schools from different levels of education that function under the same directive board and develop a common pedagogical project they consider adequate for their social and cultural reality. This case study is centred in the collaborative activities developed by the "Alfredo da Silva" School Cluster, represented in COSMOS by one primary school and one secondary school. Sometimes it is hard to individualise the work developed in each educational level because of their collaborative nature. "Alfredo da Silva" school cluster is integrated in the border zone between the Lisbon outskirts and a rural area.

Some of the teachers involved in this process are used to implement activism initiatives based on an inquiry-based science approach. They are part of a Community of Practice (CoP) that has received support from the Institute of Education at the University of Lisbon – IE-ULisboa, a COSMOS partner, for 13 years. This CoP is dedicated to fostering students' and teachers' activism, defined as a collaborative and democratic approach to addressing socio-scientific or socio-environmental issues that impact their communities. The involvement in COSMOS activities was a consequence of this long and strong collaboration.

This case study is centred around the 2022-2023 school year, a turbulent period affected by strikes among school teachers and workers in Portugal.

The CORPOS

The CORPOS was developed based on the strong personal and professional relations existing between the IE-ULisboa team members and one of the school cluster teachers. This teacher had a very important role in mobilising other teachers (from different levels of education) to the CORPOS. The fact that they work in cluster, provided a context in which internal collaboration between different levels of education already existed. Three significant factors played a pivotal role in the development of CORPOS within the school cluster:

1. The active participation of certain teachers in the Activism Community of Practice sponsored by IE-ULisboa. The CORPOS was maintained/supported by the strong collaboration and the shared culture/interest (between the IE-ULisboa team and these teachers) in terms of the importance attributed to inquiry and activism initiatives implemented by students and teachers. This culture has been developed during a 13 years' long process of collaboration associated with a CoL centred on that kind of initiatives.
2. The positions of leadership regarding pedagogical innovation and project implementation in schools occupied by those teachers.
3. The presence of a "Science Club" dedicated to fostering collaborative projects involving students, teachers, scientists, members of science centres, parents, and other community members, supported by Ciência Viva – a societal partner of COSMOS.

Some obstacles to CORPOS development were also experienced: a) the strike affecting the school functioning; b) time constraints and a work overload experienced by many teachers; c) lack of teachers' motivation to participate in long TPD processes; d) the reduced number of teachers wanting to participate in the project.

The CORPOS was formed by the primary and secondary school teachers and the members from IE-ULisboa and Ciência Viva. The school cluster's director was not directly involved but entirely supported all the implemented activities and initiatives, delegating the authority to the teachers to decide on their participation/involvement in COSMOS. The contacts between the CORPOS members were established both through videoconference, phone calls to the main teachers involved and meetings in the schools by IE-ULisboa team members.

The multi-level structure of this CORPOS – with representatives from primary and secondary schools – upheld and further explored the tradition of Portuguese school clusters in terms of collaboration between education levels, with the aim of developing shared pedagogical projects they consider suitable for their social and cultural context.

The SSI

The SSIBL theme (How to live in a planet that shakes? Are we ready for an earthquake?) was decided mainly by the school teachers of the CORPOS, based on their knowledge of the students' interests and of the curricula of the different school levels of education and subjects involved. Students' questions and worries were motivated by the earthquake (with severe consequences) that had just happen on that time in Turkey and Syria. And they knew that Portugal – both the mainland and Azores – is a place with high seismic activity. So, students were inquiring a lot about the possible effects of a similar earthquake in Portugal and the country's readiness level for such an event.

The intervention of both IE-ULisboa and Ciência Viva members were mainly through the suggestion of possible activities and collaborations. However, all the activities were developed mainly by the teachers' group, with a high degree of independence/autonomy from the other CORPOS' members.

The Community of Practice (CoP)

A CoP was created in order to support the SSIBL implementation about the chosen topic. Some characteristics of the school cluster facilitated the CoP development: 1) some level of teachers' autonomy in adapting the curriculum for the incorporation of dimensions – topics, skills and attitudes – considered socially relevant; 2) a community already established with the aim of coordinating the "Science Club" activities; 3) some experience in stimulating the involvement of families in school activities proposed by teachers; 4) the collaboration between different education levels; 5) some tradition in involving students and teachers in social actions with positive impact in the community.

The turbulent period in which the CoP was developed – affected by strikes among school teachers and workers in Portugal – compromised some of the actions planned for the community.

The selection of the CoP members was done mainly by the teachers and according with the specific context resulting from the selected theme by the school cluster and the strikes that were happening during that period. Other CORPOS members had an important role suggesting possible collaborations, discussing/improving the planned activities and supporting teachers and students through local visits to the classes where the activities were being implemented.

Several people were involved in this specific CoP: 1) all the CORPOS members (teachers and all the members from IE-ULisboa and Ciência Viva; 2) more teachers from other subjects – a Portuguese Language teacher and an English Language teacher – in order to support different phases of the project; 3) one specialist from "Civil protection" to present information about the topic and to discuss with the students ways of reducing the probabilities of bad consequences from earthquakes; 4) one student belonging to the fire department, to discuss with her colleagues ways of reducing the probabilities of bad consequences from earthquakes; 5) one Portuguese Language teacher; 6) one English Language teacher; 7) students from 2nd, 7th and 8th school years, involved in the different phases of the COSMOS activities; 8) one family member with knowledge of Mandarin Language to support the action phase; 9) the students' family members – many of the activities were planned in order to involve the students' families in their development, in order to increase the action/formative dimension of the project.

The COSMOS activities were primarily determined by the CoP teachers, while other CoP members were given a secondary role with minimal involvement in the decision-making process. Some of the external members didn't have the motivation or the willingness to be involved in all the phases of COSMOS process; they were only available for some fast contributions involving visits to the schools. But the teachers also had some difficulties planning and establishing collaborations with external groups/institutions. During an unstable period, due to the strikes, it was almost impossible for the teachers to plan more stable and continuous collaborations with other members of the community. The number of teachers was not the same during the entire project, with some of them being more involved in specific phases (teacher from other subjects collaborating in specific tasks – e. g. teachers of English and Portuguese languages).

The COSMOS SSIBL approach was presented based on concrete examples of students' actions taken from out previous CoP supporting activism initiatives. The previous experience of some teachers with a very similar approach facilitated the understanding of all approach by the participants.

The Activities

The teachers based all the activities in the students' worries (and questions) about a possible earthquake happening in Portugal and the readiness level of the country for such an event.

In all classes (2nd grade Environmental Studies, 7th grade Natural Sciences and 8th grade Chemistry and Physics), students were analysing some news about the earthquake that happened in Turkey and Syria and all its tragic consequences. They also discussed about the tragic Portuguese experience with the earthquake of 1755 that destroyed Lisbon (and many other areas of the country), killing between one third and one half of the population. Students were also remembering the earthquake drills in which they were participating in school in the past.

In the following task, in Environmental Studies (2nd grade) and Natural Sciences (7th grade) classes, students inquired (using books, Internet and videos) about the causes of the earthquakes (plate tectonics) and the internal structure of the planet Earth and building models of the internal structure of the planet Earth. In the Chemistry and Physics class (8th grade), students were inquiring (using books, Internet and videos) about the consequences of the earthquakes in terms of fires. This focus was motivated by the big fires that destroyed Lisbon after the earthquake of 1755. In this phase, all the classes had the support of an expert from "Civil Protection" who visited them in school and discussed with them ways of reducing the probabilities of bad consequences from earthquakes.

In the upcoming task, during Environmental Studies (2nd grade) and Natural Sciences (7th grade) classes, students explored potential strategies to mitigate the impact of significant catastrophes resulting from earthquakes. They developed a list of items to observe in order to detect possible risky situations in different buildings and used it in different parts of their school and homes. The results were presented and discussed during classes. Later, in both classes, groups of students prepared self-protection emergency kits (inside backpacks, to have at home) with the most important objects necessary during an earthquake emergency. This kits, developed together with their families, were presented during classes.

In the Chemistry and Physics class (8th grade), students inquired about possible ways to avoid big fires (e. g. as a consequence of earthquakes). They also inquired about the level of readiness of the school to fight some fire in the building. In this task, students had the help of a colleague (who visited their class) from another 8th year class that is a junior member of the fire department (and consequently, having training in firefighting). This session was quite appreciated by all the students (the presenter and those from the class), who had the opportunity of discussing a lot about the topic. After this activity, students built (in groups) videos on how to prevent fires and how to behave during a fire in school or at home

In Natural Sciences class (7th grade), they also built (in groups) a digital presentation or a scale model of different rooms of their homes where they signalled the safe and dangerous places during earthquakes. Students discussed ways of preventing different possible dangerous situations inside their homes because of an earthquake. These works were also presented and discussed in the class. Finally, they produced (in groups) videos on their different learnings about earthquakes and how to behave during such an event. These videos were prepared in Portuguese, English and Mandarin (with the support of Portuguese and English Languages teachers and one parent with knowledge of Mandarin).

During this stage, the 2nd grade class was visited by their school mates of the 8th year (from the subject of Chemistry and Physics) who were presenting their final works on how to prevent fire events in school and at home (e.g. as a result of an earthquake). Primary school students had the opportunity to discuss the topic with their colleagues from the 8th grade. This session was appreciated by both groups of students. Later, the 2nd grade students built (in groups) a scale model of different rooms of their homes where they signalled the safe and dangerous places during earthquakes. These scale models were used to simulate an earthquake – shaking the models – and to observe the consequences in the rooms with different types of furniture. Students discussed ways of preventing different possible dangerous situations inside their homes as a consequence of an earthquake. Finally, a video was prepared collaboratively between the teacher and the students with what they considered as their most important learnings.

The ACT component of SSIBL involved several initiatives. The videos prepared in the different classes and school years, with their different learnings and messages, were published in the schools' social media in order to be spread to the entire community.

In the Chemistry and Physics class (8th grade), with the conclusions they reached about the school level of readiness to fight a fire in the building, students wrote and sent a letter to the directive board asking for the implementation of specific actions in the school. In this task, they had the help of the teacher of Portuguese Language. As part of the ACT phase, they also visited their colleagues of the 2th year (from the Primary School) to present their final works (and conclusions) on how to prevent fire events in school and at home (e.g., as a result of an earthquake).

To increase the action component of the COSMOS project, some of the activities, proposed by the 2nd and the 7th grade, were planned to involve the students' families in their development (e. g. the self-protection emergency kits). This way, the formative component reached their families.
Some other action initiatives were planned by the teachers. However, the suppression of classes due to the strike compromised their implementation.

COSMOS' CoP Impact

The COSMOS project was well received in this school cluster.
We were successful approaching school staff who: a) have been involved with us in previous projects; b) were motivated to work with us; c) already shared a common repertoire with us regarding the implementation of inquiry and activism initiatives in schools; and d) have positions of leadership regarding pedagogical innovation and project implementation in schools.

Students enjoyed a lot the activities and the learning impact was evident, mainly in what concerns the development of inquiry and communication skills and action competences. Teachers mentioned that they always appreciate collaborating in this kind of projects because they allow them to learn more pedagogical knowledge and to continue implementing activities combining science education, citizenship education and school activism. The implementation of the COSMOS' approach was facilitated by the previous involvement of some teachers in a CoP (supported by IE-ULisboa) centred on students' and teachers' activism: the SSIBL-CoP has a lot in common with the initiatives previously developed.

However, COSMOS' implementation faced two major challenges. Firstly, some teachers' reluctance to participate in additional projects and teacher training initiatives, citing what they perceived as an already heavy workload. Secondly, the teachers' and school workers' strike during the school year resulting in the cancellation of several classes and leading to the postponement or cancellation of pre-planned COSMOS activities. These obstacles were possible to overcome by reducing the duration of

the COSMOS' teacher professional development initiative – what was possible due to the teachers' previous experience with the implementation of activism initiatives based on an inquiry-based science education approach – and by the teachers' willingness to collaborate with us as a result of they considered as previous positive personal and professional relations between the teachers and the IE-ULisboa team and also between the teachers themselves. Without these previous successful experiences between different elements, the CoP would become quite difficult to achieve.

The COSMOS' CoP was quite effective in promoting collaborations between school levels. However, the collaboration with external institutions or groups was quite affected by the strike and the consequent "reduced mode" implemented by schools. The action component of COSMOS was also affected by the strike and the consequent suppression of several activities planned for those days.

The main lessons learned by the CoP during this participation in COSMOS activities relate to the need to:

1. Start the next COSMOS implementation much sooner than last year in order to allow a much calmer and better planned process;
2. Find ways to promote the participation/involvement from external community members;
3. Increase the number and range of action initiatives in the community around the school;
4. Overcome some school cluster limitations regarding the level of openness to community, focusing next year efforts in improving the connections and collaboration with external members of the community.

2.5. The case study from Sweden

Working with a theme about Genetically Modified Organisms (GMO) within the COSMOS project – a case study from a Swedish secondary school

Within the COSMOS project a model has been developed of how to create organisational structures that can stimulate school openness in science education. The model presents the concept CORPOS which is a group of people from school, a higher education institution (HEI) and a societal partner. In addition, the COSMOS model includes the creation of a Community of Practice (CoP) involving other stakeholders who are of interest depending on which SSI theme is chosen as the topic to work with. The theme is supposed to be worked on through the SSIBL (Socio-Scientific Inquiry-Based Learning) method. In this case study, we present an example from a Swedish secondary school, how the different

components of the COSMOS model were integrated, the successful parts, as well as the challenges that occurred and strategies of how to handle the challenges.

The characteristics of the CORPOS

The initiative of establishing contact and creating a CORPOS was made by the HEI, in this case, Karlstad University. First contact was made with the school science teachers by Karlstad University via email and during the autumn of 2022. The next step was an online meeting in which the teachers and principal of the school were informed about the COSMOS project in detail and a dialogue was started on how and when to start working together. Previous collaboration had existed for many years between the school and Karlstad University. The reason for contacting this specific school was also the experience of the school being interested in developing their science education and their interest in collaboration. The school is a secondary school, situated in the middle of Sweden in a municipality with about 10 000 habitants.

The first teacher professional development (TPD) and planning meeting was held in February 2023 with two science teachers and during this half day meeting the COSMOS approach was discussed and the openness level wheel (a tool developed within the COSMOS project) was used to identify the current level of the school's openness. Working with SSIBL was not new to the teachers, hence not so much time was needed to spend on TPD from this aspect. In the next step, meetings were held between the school and the societal partner, the Alma Löv Museum to plan how to work with the chosen theme about GMO based on the SSIBL approach. (The reason for choosing GMO as the theme will be presented in the next section.) The school teachers also had previous collaborative experiences with the Alma Löv museum.

The main CORPOS members consisted of a senior researcher from Karlstad University, two science teachers coordinating the COSMOS project for the participating school and a museum educator as representative for the Alma Löv museum. The CORPOS together planned how to work and the duration of the activities. Some of the SSIBL activities were planned to take place in the school and others at the Alma Löv museum. The principal of the participating school was very engaged and supported her teachers to join the project and in practical issues of organising full day activities. During the implementation round, the principal also attended two meetings between the HEI partner and involved teachers.

Creating a CoP

The reason for choosing GMO as the SSI theme was based on first of all, the connection to the curriculum with learning objectives related to genetics and GMO. Another reason for choosing this specific theme was that the Alma Löv museum have a special program based on GMO. To find other stakeholders than the CORPOS members was in this case problematic. There are no organisations in the region working with GMO. Hence, the CORPOS became the same as the CoP. The science teachers planned most of the activities taking place, except for the activity at the museum and also a follow up activity at the school where the museum pedagogy was responsible for the activity. The researcher from the university supported the teachers with some materials, an interesting pod about GMO, articles and also some names of researchers working in other parts of the country with GMO questions.

As mentioned before, the school is situated in the middle of Sweden, in a quite small municipality. The school has about 300 students from mixed sociocultural backgrounds divided over three year-groups (7-9), the students being in the age of 13-15 years. In this case study the participating year group comprised almost 100 students divided over four classes that were assisted during the activities by their regular subject teachers, mentors and museum-educator. The students were from grade 8 (14-15 years old).

The school context

The school has a long tradition, as all other schools in Sweden with an internal school organisation in which teachers work in teams. In addition, in the Swedish school culture there are no rules what kind of instructional strategies teachers should chose when teaching science, there are only learning objectives in the curriculum serving as guide for the teaching. Teachers can choose how to teach by themselves. Hence, they score themselves as very outward on the dimensions of shared governance and curriculum in the openness level wheal. As already mentioned, the teachers work in teams and therefore they argue that their inner school communities are considered as quite outward as well.

In terms of learning communities, the teachers rate their school as somewhere in the middle, it used to be more outward earlier, but the students need a lot of structure and support, so there is less project-based learning activities and group work at the moment compared to a couple of years ago. When it comes to parent involvement the teachers sometimes wish that parents were more involved, but this is problematic because of the cultural differences, with parents sometimes not knowing the language and having almost no education themselves. In many cases the teachers also believe that

parents put a lot of respect to the teachers and the school, but in the end, they argue that when it comes to parent involvement the school is in the middle between inward and outward.
Students have a special student council at the school, and they are free to contact the principal and the teachers in their offices, it is a friendly and open atmosphere between students and staff. Students are listened to, but they cannot decide what to learn and when to have different subjects, etcetera. This is regulated by the school. Hence, student participation is marked as somewhere in the middle of inward and outward in the openness wheal. The school is not involved in any external social engagement, there is simply too much of this as part of the work teachers already do with their students. So, in a sense they have a lot of social engagement, sometimes more than they wish, not having enough time for teaching subject content. However, they feel unsure of where to put themselves in the openness level wheal based on what is meant by social engagement, but if it is about engaging in projects out of school the teachers feel that they are quite inward and there is room for development. Finally, community collaboration. Even though the school has collaboration with the university and the Alma Löv museum they wish that they could have a lot more of community collaboration, since this is experienced as something positive, especially for the students.

The SSIBL implementation

As already mentioned, the CORPOS chose to work with GMO and the ASK part was presented to the students as whether GMO is something good or bad. The FIND OUT phase consisted of several activities and the activities conducted by Alma Löv are not traditional in science education, since the learning units during this part are based on activities with art in focus. This we believe is an innovative way of working with SSIBL! Together with the societal partner, the schoolteachers and students cooperated and participated in a pre-structured museum program based on theories within context-based, interdisciplinary and value-centered learning and inquiry-based learning by using a technique called Visual Thinking Strategies.

First, the teachers were introduced to the aims, themes and structure of the Alma Löv program during a staff meeting with the museum educator. Full resources were provided by the museum such as teacher guides, fact sheets, presentations, mind map templates and construction materials. All resources connect to abilities and central content in natural science and aesthetic subjects according to the national curriculum.

In the next step, the Alma Löv program provided structure to both teachers and students in the following ways:

- The program was clearly divided into three successive phases: prepare (pre-visit), explore (visit) and create (follow-up visit) The phases were carried out on separate days.
- The adapted version of the artwork analysis tool VTS (Visual Thinking Strategies) gave both students and teachers structure by following a strictly determined order of questions that repeated itself throughout the program in group discussions and mind maps.
- The theoretical content of the program, in this case GMO, constitutes a limited area of knowledge and there were clearly defined activities in all phases.

The construction of student artwork, the writing of associated descriptions, and the presentation of their own work in the creation phase encouraged students to recall, discuss, and present the knowledge gathered during the inquiry phase. Students worked in pairs or in groups of three. Students wrote mind maps and constructed works of art together with teachers and museum staff. All phases of the program were aimed at a final product: a contemporary art exhibition about GMO for schoolmates, parents, teachers, school leaders and other interested parties. Student groups analysed professional artworks, discussed mind maps and created artworks in consultation and collaboration with museum staff and teachers. Researching information on GMO, choosing a subject for a work of art, and deciding on the content of the description required discussion among peers.

The choices of professional artworks, questions about GMO, the experience of the "odd" museum environment and the active pedagogy aroused students' curiosity, interest and lead to engaged discussions. Students chose their own angles on GMO to show in their artwork and description. The students received a short workshop in clay sculpting for expressing their thoughts, feelings and knowledge about GMO from their concept map into a sculpture. There are no "correct answers or results" but conditions were given for students to express their own thoughts and show their commitment. Students were encouraged to analyse works of art by sharing thoughts, personal experiences and prior knowledge with their group. The students are challenged to write down and structure their interpretations in mind maps. They examined new information about artworks from descriptions to deepen their discussion of the artist's intentions and the connection to the natural science theme. Students were challenged to break down a work of art into the concept behind it and vice versa to build a work of art from their own ideas and knowledge of a concept. Figure 1 shows an example of student group work with the sculptures about GMO. Students were encouraged to share their own experiences, opinions and private thoughts with which artworks are associated. Besides the activities taking place in collaboration with the Alma Löv museum, some lessons were also held at school where the students searched for information about GMO. Finally, the students had some

debate discussions about whether GMO is something good or bad. This part was considered as an ACT phase in which the students were presenting pro and con arguments of GMO.

Figure 1. Examples of creations made by students during FIND OUT activity about GMO.

As a strategy to involve parents, other students from the school and the public, an exhibition of the students' artworks and thoughts about GMO was planned to take place at the public library in the municipality, or in the school cafeteria. However, the exhibition was postponed to later on, since the activities were taking place at the end of the term and summer vacation was approaching.

Evaluation of the SSIBL-CoP implementation

The students were very engaged during the project and after the visit to the Alma Löv museum where they made the first FIND OUT activity students talked about how much they appreciated the visit and the activity, saying that this was something they wanted to do more often. After the activities the students were interviewed and asked what they thought about GMO they argued that they learnt more when they went to the museum compared to if they had only stayed at the school. The environment was also inspiring according to the students. They also mentioned that it would have been interesting to visit a science laboratory and find out how GMO actually are made. The students said that they had learnt a lot about GMO and that they found it as something both good and bad. Finally, the students argued that they learnt so much more working this way and that it was an interesting topic. The only thing they had wanted to change was to have more time, to work with inquires in a laboratory as well.

The teachers were also positive and wished that they could have more learning activities outside of school. They argued that it is inspiring for the students and that it is good for the students to get

information from others, not only from school. Students can be more motivated when they learn in another context. However, every group of students is different, and some groups are difficult, and it can be quite challenging to take such groups out of school. On the other hand, maybe that would be a success? Still, as teachers they feel a bit afraid of bringing rowdy classes to museums or enterprises. In this case, everything worked great even though the participating classes were different in terms of being mature and taking responsibility during traditional lessons.

The actual work with SSIBL worked very well and no difficulties were reported on this part of the implementation except for the lack of time and the time of the school year of working with the project. The way to handle this was that teachers decided to continue the work during the text term, after the summer vacation. The teachers argued that it would have been better to do this at autumn terms, not during spring when there are many national tests going on.

From a CoP perspective we can report that creating collaboration between the school and Karlstad university was an easy task since there is a well-established network between schools and the university in the region. On a yearly basis Karlstad University is accustomed to organising TPD activities and joint projects to stimulate interest in STEM among students of all ages. Furthermore, in Swedish compulsory schools, different subject-teachers often work in teams with specific classes and year groups which naturally facilitated the implementation of the COSMOS approach. The principal of the participating school in this case study was very engaged and supported her teachers to join the project and in practical issues of organising full day activities. During the implementation round the principal also attended two meetings between the HEI partner and involved teachers. Besides these positive conditions to catalyse the Swedish CoP it can be added that the school already had previous collaboration with the societal partner the Alma Löv museum, therefore being familiar with its staff and premises. The learning activities were co-designed between the teachers and Alma Löv museum. In addition, the teachers were supported with some materials about GMO from the university.

However, there were challenges as well, to find stakeholders that in any way worked with the chosen SSI theme, GMO. This is not existing in the region. Hence, the CoP was not extended to involve more partners than from the school, the university and the museum.

The impact of COSMOS on the participants and school openness

This school has previous experiences of collaborating with the university and the Alma Löv museum and part of the science education and considered as being open, interested in collaborations, different

teaching strategies etcetera. The teachers already were familiar with SSIBL, hence the starting distance for the school to work with the COSMOS approach was short. In addition, the way of working in teams as teachers, an already existing organisational structure also contributes to school openness.

One of the dimensions not being so open is the collaboration with parents and this was not changed during this implementation round but planned to involve the parents via the planned exhibition. The teachers presented several arguments why there is not so much collaboration with parents based on issues of the families being from different cultural backgrounds, sometimes being new immigrants not even knowing the language. This is a dimension the school struggles with and that is not easily solved.

Collaboration with the surrounding society was something both teachers, the principal and students argued as something they wanted to have more. The participation in the COSMOS project was a reminder to the teachers how positive this can be both for the teachers and the students. Hence, a dimension of openness they wanted to continue to develop.

2.6. The case study from the United Kingdom

CORPOS

During Round 1, we have worked with one secondary school to develop and implement one SSIBL-CoP implementation with 4 science teachers and approximately 120 Year 9 pupils (13-14 year olds). The networking, CPD and collaboration meetings that took place with the school as part of establishing and maintaining CORPOS, and identifying CoP members are reported in this section.

The collaboration with this secondary school was initiated from one of the Year 9 science teachers, (which will be referred to as the 'lead science teacher' in this report). The lead science teacher, studied for their teacher qualification degree at Southampton Education School, and so had prior connections to the SOTON partners. The lead teacher contacted the SOTON team expressing interest in collaborating with us on science education projects, as she was keen to maintain a professional connection with the University. In July 2022, an initial recruitment meeting took place between the SOTON team lead and lead science teacher in school; the key project objectives and timeline were shared with the teacher and an initial discussion took place on how we could work with the Science Department. Dates for the focus group discussion with the science teacher team, and dates for the CPD workshops were provisionally set at the end of this recruitment meeting.

At the end of September 2022, all SOTON and WSC partners attended an afterschool meeting for the first focus group discussion on school openness and a further discussion of project concepts with the science teacher team (3 science teachers attended). This meeting was the starting point for the establishment of the CORPOS team at this school, which consisted of:

- The three Year 9 science teachers: the female lead teacher, a male teacher, who was the Assistant Head of Department, a male science teacher
- One societal partner from COSMOS consortium (WSC)
- Three HEI partners from COSMOS consortium (SOTON)

The outcomes of the school openness discussion are presented in Figure 2, which provides the combined assessment of the school openness based on the COSMOS openness dimensions. The areas that the teachers decided they would like to focus on were Student Participation, and Community Collaborations. Student Participation was considered important by the teachers due an element of apathy they observed in students' approach and attitudes at school when it came to contributing or participating to the school community, as shown in the following extract:

> *Teacher 2: I have a tutor group and I said, "Right, we need three student reps, to represent our school," and we had two. And yeah, to get a third, it was a bit of a nightmare, but this is apathy. And then they said, "We need a charity rep, does anybody want to be a charity rep?" "Well, I don't want to be it from last year anymore." Okay, so we've eventually now got four people for four positions. But it took a while, and in the end, it's just three out of those four are the ones who generally will volunteer for everything, but if you say, "Right, let's try and capture the ones that might be Pupil Premium, or the ones like this," they just don't want to know, they just don't want to be bothered, they're not...*
> *Teacher 3: They don't see the value.*
> *Teacher 2: They don't see the value, which is a sad, sad situation and it annoys me.*

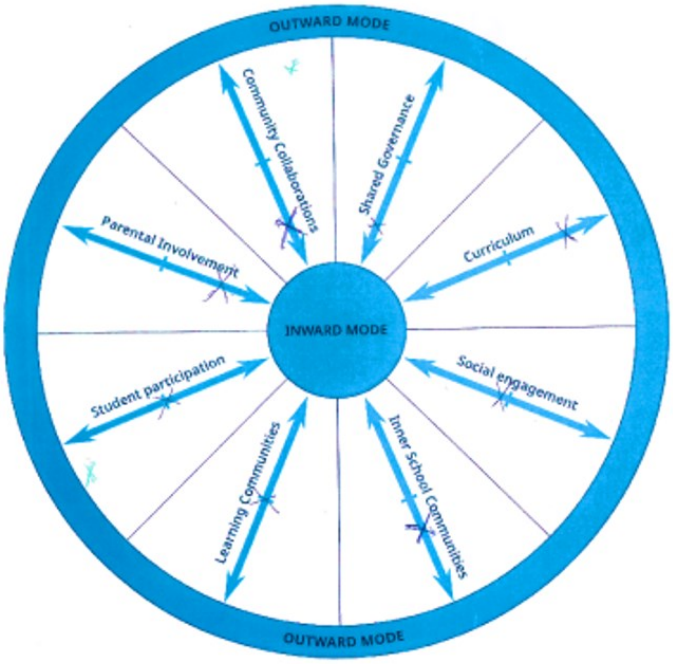

Figure 2: The teachers' combined visualization of their school's openness dimensions at the start of Round 1.

As part of the focus group discussion, we also had an initial discussion with the teacher team about what areas they would like to focus on with their pupils. This included an exploratory discussion of SSIs that were relevant to them, their students and the school, such as food availability with local food shortages in shops, electric cars that is a hot topic in the news and the complexity of recycling with the different numbers of bins students saw at home and at school.

CORPOS, TPD work and Community of Practice development

The CORPOS team collaborated closely in developing and delivering the two TPD workshops that were organised for October 2022. In the first TPD workshop (2nd October 2022), we focused on discussing key concepts in SSIBL. We discussed SSIs that would be relevant to pupils and to the school team (e.g., waste management as students came from a large geographical area across local councils and so they had different rules for recycling waste at home and at school[1]. We then conducted a stakeholder analysis to discuss who at the school would be interested to be involved (e.g., school careers advisor)

[1] It is common for local councils in England to follow different rules and offer their residents different guidelines when it comes to recycling. For example, some councils will recycle tetra packs and others will not; some coun-cils will provide green waste bins for plastics recycling and others a brown colour; it is therefore easy for stu-dents to be confused about which rules to follow.

as well as which external stakeholders we could approach, depending on the SSI discussed (e.g., a local zero-waste shop to discuss the issue from the consumers' perspective, local waste management sites, local council offers dealing with waste management). The SOTON/WSC team then created a list of local SSIs that could be used, that were then discussed during the second TPD workshop (17 October 2022).

During the second TPD workshop, the focus was on community engagement and starting to shape the CoP membership and ways of working together. To start creating our CoP, we presented and discussed with the teachers our own network links, and did a school community audit, where several external stakeholders were discussed and suggested as potential collaborators. The teachers were interested in preparing pupils to be citizens of the future, and 'teaching them the skills to be able to make decisions in their everyday lives' (CPD 2 workshop notes, 17/10/22). The discussion around the importance of addressing socio-environmental issues continued into this workshop, and as a result, the topic of waste management was selected as the SSI to explore collaboratively with pupils and the school community. This was based on the teachers' conversations with pupils, which indicated that pupils were not aware of the waste management and recycling systems in place at the school, and confusion existed even between teachers about whether plastic and paper was recycled at school. The teachers expressed concerns about time pressure and increased curriculum demands and based on this challenge we decided to organise a Science day for four classes of Year 9 students (13-14 years old), a total of about 120 students. The school leadership team had agreed to release these students from their normal timetables so they can work on COSMOS activities for the full Science day. By the end of the second workshop, we had discussed different elements of our SSIBL unit (Figure 3) and an overall sequence was planned as shown in Table 1.

Social & Personal Inquiry	Science inquiries could focus on:
Pupils to find out what the school does with waste	Learning about plastic-eating worms as a solution
Pupils to find out what happens to waste at home & at community level	Microplastics and their impact
	Recycling
Pupils to express own views about the issue	Materials
	Climate education lesson

Figure 3: Types of inquiry discussed during TPD workshops based on the agreed SSI (waste management)

We used these ideas to continue communication over email and had three further co-design meetings in person (5th December 2022, 6th February 2023, 12 March 2023) in preparation for the SSIBL Science day on 28th March 2023. During these meetings we discussed the lesson sequence, agreed on the activities that we would carry out with the pupils and shared responsibility for preparing

resources. Our co-design approach was flexible, with sharing responsibility for the co-design of some of the materials and allocating materials to be created to different CORPOS members, where needed. For example, we co-designed the homework task that was prepared to introduce the issue to pupils and to engage them in the ASK phase of SSIBL. The lead science teacher drafted initially the online questions for the pupils' homework task, and COSMOS partners adapted and gave feedback to ensure it was asking a socioscientific question. This concluded in asking the students 'What happens to your waste after you drop it in a recycling bin', with follow up questions about 'Reduce, Reuse, Recycle'. The teachers then gave further feedback on how to formulate the follow-up questions on the meaning of 'Reduce, Reuse, Recycle' to ensure pupils would understand them and be able to engage with the task. Two further valuable members of staff within the school were identified during the TPD workshops; a careers adviser, who was able to attend the second TPD session as a new CoP member, and a Community manager, the latter being a new member of staff (in an existing position) that supported the community with initiatives such as a food bank for local families.

Table 1: SSIBL – CoP implementation on Waste Management in a UK secondary school

SSIBL dimension	Description	Duration
ASK	SSI question: What should we do about waste management at our school? Pupils were sent online an activity task where they were asked to report on what they know, understand and would like to know more about in relation to waste management (see Appendix A). This was set as an online homework task. The pupil responses were analysed and used in Lesson 1, where the focus was to introduce the key SSI question, share their questions and responses to the homework task, and engage them in a controversy mapping task in order to help students understand the multiple perspectives that this SSI has, and the complexity of it (Appendix B includes one of the controversy maps pupils created). During the lesson, teachers also set the scene for the SSIBL Science day, explaining that their work during that day will help them identify solutions and then vote on which are the best to propose to the school. (All four teachers taught the same lesson with their Year 9 classes).	Pre-lesson task circulated via Google Classroom online (10 min approximately to complete, w/c27 Feb 23) Lesson 1 (50min approx., w/c 20th March)

FIND OUT	Pupils were asked at the end of Lesson 1 to write down what they personally think should be done about waste management at their school (personal inquiry). Pupils were introduced to the waste management theme of the Science by Professor Ian Williams, an expert on waste management based at Environmental Sciences, University of Southampton. Each class then circulated around four thematic rooms where they got to investigate information about Battery recycling and disposal, food waste, fast fashion, plastics recycling (Appendix C). Pupils were then asked to work in groups to design a poster identifying solutions for their school answering the question 'What should we do about waste management at our school'.	Lesson 1 (50min approx., w/c 20th March) SSIBL Science day (5 hours)
ACT	Voting: At the end of the SSIBL Science Day, pupils and teachers voted for the posters with the best solutions. SSIBL pledge - Considering personal action: After students voted for the best posters, they were asked to individually consider what actions they could take personally in order to address the issue of waste at home and at school and make a SSIBL pledge to act upon. Advocating for action: The students groups of the top three posters (Appendix D) presented their solutions to the school's senior leadership team, and other CoP members.	SSIBL Science day (5 hours) SSIBL Science day (5 hours) Presentation to CoP about solutions identified (50min approx.., 14 June 2023)

Reflections on CORPOS

Overall, the collaboration and professional relationship we established between SOTON/WSC and the three teachers, as well between us (SOTON and WSC partners) has been a key strength and positive outcome of the work we have conducted on formulating CORPOS during Round 1. The frequent communication with school teachers, by email, and our in-person workshops and meetings supported this process. All CORPOS meetings we had were in-person, which facilitated engagement and supported more in-depth discussion and exploration of issues. Previous professional relationships between three of the four teachers and SOTON partners also facilitated communication and strengthened CORPOS (teachers had completed their teacher training qualifications at Southampton Education School and knew some of our team). Another key strength that facilitated the facilitation of CORPOS and the co-design process was the lead science teacher's commitment to the project and the fact that she took responsibility for leading and managing internal processes in preparation for the science lessons and SSIBL Science day.

Community of Practice development

The SOTON/WSC partners worked on contacting their own networks where relevant or contacting stakeholders around the school community to find out more about their work, and to invite them to be part of the CoP for this SSIBL-CoP implementation. The school teachers focused on networking and community engagement within the school, maintaining links with the careers advisor and inviting a Geography teacher (who was also the Environmental Student Group coordinator) to take part in the 12th March co-design meeting.

The CoP membership included all CORPOS members and the following:

1. SOTON academic from Biological Sciences department
2. SOTON academic from Environmental Sciences department
3. 1 Geography teacher (also student Environmental Group coordinator)
4. 1 School Careers Advisor
5. School Headteacher
6. School Deputy Headteacher
7. Chair of Governors, Gateway Academy Trust
8. Chief Operating Officer, Gateway Academy Trust
9. School's Science Curriculum Leader
10. School's Site Manager
11. Senior Manager, Romsey Community Services

Members 5-11 were mainly involved in a supportive role, and at the last school event where students presented their solutions as part of the ACT phase. Expanding the CoP to include external collaborators was a challenge due to several factors including potential stakeholders being unresponsive to our collaboration invitations, stakeholders being unavailable to attend meetings or the SSIBL Science day, whose date was set for 28th March. However, where possible we had discussions with stakeholders that could inform the FIND OUT stage of the SSIBL unit. For instance, we consulted with academic staff at Winchester School of Art who specialise in sustainable fashion. Two academic members of staff from the University of Southampton, were able to support the FIND OUT stage of our SSIBL-CoP implementation. One academic who researches waste management opened the day doing a plenary presentation to all Year 9 pupils taking part, and another academic who specialises in food systems took part by supporting students with their investigations on Food Waste as part of the Science day.

Reflections on CoP work

Our CoP was formulated by expanding the CORPOS team to include other school members. For example, the school's career advisor was invited to attend our second TPD workshop and maintained communication and offered support throughout the remainder of the project implementation at school. The key purpose of the CoP developed was to support the implementation of the SSIBL unit designed, although CoP members were also involved in the design process (e.g., school career advisor). Two CoP members (careers advisor, geography teacher) collaborated with CORPOS in the co-design and implementation of SSIBL activities (ASK, FIND OUT, ACT stages). Another CoP member (sustainable fashion expert) contributed to the co-design by offering information and advice on sources of information to use for the Fast Fashion theme. Other CoP members, such as the school headteacher and the school site manager, although supportive of project activities, they were less involved and interactions with these members were more transactional than collaborative as a result. This meant that support was offered (e.g. the Year 9 students were allowed to not attend their usual lessons during the Science day so they can focus entirely on their SSIBL-CoP implementation activities), and information was provided when requested to support the Science day and the subsequent presentation by pupils to CoP members. However, these school-based CoP members were not involved in the FIND OUT stage of SSIBL-CoP implementation. The challenges we faced with initiating a CoP was the fact that the secondary school we worked with was a large comprehensive school, with several members of staff in each department. This meant that forging relationships with members outside the CORPOS team was challenging, unless members were willing and available to take part in already planned meetings (as was the career advisor, and the geography teacher).

Nevertheless, we succeeded in creating a CoP that was interested, invested and willing to support the SSIBL-CoP implementation on waste management within the school community. This success and commitment were shown during the last SSIBL-CoP implementation activity, where the majority of the CoP members were present to listen to the pupils' proposed solutions and to engage with them in conversations about their learning and about their views on what they think the school should do to support and implement their proposed solutions. Feedback from this ACT stage of the SSIBL-CoP implemented pointed out the positive presence of both internal and external to the school members attending ('Good to see internal and external "movers and shakers" discussing the issues').

COSMOS' CoP Impact

The main success of the approach taken for our SSIBL-CoP implementation was the fact that a large number of pupils from the same year group were able to participate in a fully interactive science day, where they had to research resources on four themes (Appendix C) co-designed by CORPOS and CoP, and then engage in decision-making in order to propose solutions to the issues explored within their school community context. CoP members were able to support the SSIBL-CoP implementation, and during this process we were able to follow and implement all three stages of SSIBL, although we were able to integrate community engagement elements in two of the three stages (FIND OUT, ACT). As the first stage of SSIBL, ASK was initiated early in the school year, and Round 1 implementation, the key SSI question was formulated by CORPOS during the CPD workshops where we discussed various SSIs that would be of relevance based on pupils' interest (e.g. using & recycling gadgets and batteries) but also of interest to the local community (e.g. food waste and food management), and our teams (e.g. socioenvironmental issues such as climate change, biodiversity loss and issues around sustainability). This SSI question was then presented to pupils through an online homework task in order to express their knowledge and views on the issue, which in turn informed the four themes chosen as a focus for the SSIBL Science Day.

School openness dimensions

Figure 4 presents the teachers' visualisation of the school's openness at the end of the school year. For both openness dimensions on which the teachers decided to focus for the SSIBL-CoP implementation, the teachers indicated some outward movement. For Community Collaborations they decided to move it further out on the openness continuum both at the science education level, based on the collaboration established for COSMOS, between the University of Southampton, Winchester Science Centre and their science department. At the school level, teachers also provided examples of how the school was trying to engage with the community and develop community collaborations, although their understanding of this also overlapped with the social engagement dimension(e.g. charity events for Africa, providing feminine hygiene products to female students etc.), and an admission that at the school level community engagement does not focus on engaging the local community of the school.

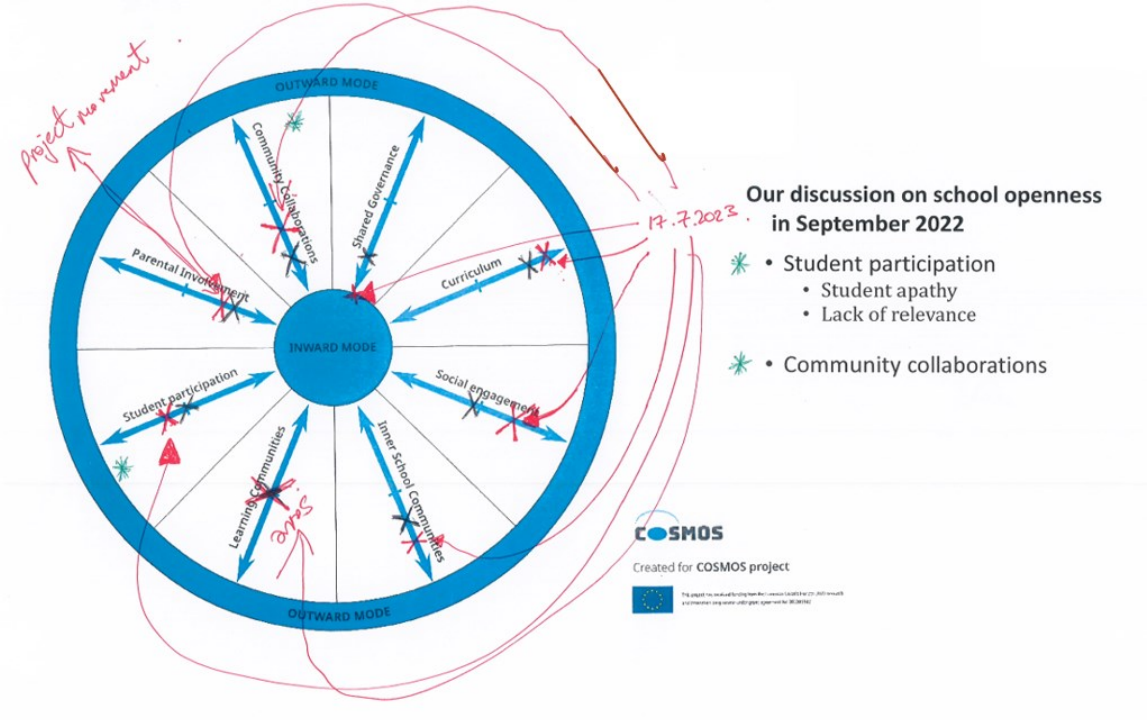

Figure 4: School's openness at the end of the school year (writing on the wheel is by the teachers).

Teachers discussion during this focus group revealed tensions between the levels at which they have observed changes in relation to the student participation dimension. They noted that 'from a project point of view, with that half a year group, that's definitely shifted [outwards], but as a department as a whole, it probably hasn't' (teacher focus group 2, July 2023). The teachers discussed the issue of student apathy as previously noted in their first focus group, and when discussing the science day and SSIBL-CoP implementation, it was clear that this had a positive impact on the students' levels of interest and engagement. For instance, they noted,

> *Teacher 1: Think all of them took something away from it, they learnt something that they didn't know, so I was saying that quite a few of them still quote little facts to me, like, "Oh my gosh, we eat, like, a credit card's worth of plastic every year…" […] And so it's all those little bits and pieces, you know, they've taken something away, they see that it is relevant, you know, it wasn't that it was something totally devoid of all meaning to their daily lives, they know that they are sort of…waste is a thing. And so I think relevancy was certainly hit by the day, and I think as a result, their apathy dissipated…*
>
> *Teacher 2: Disappeared.*
>
> *Teacher 1: Yeah, because we didn't really have any behaviour issues, did we?*

Teacher 2: No.

Teacher 1: They were all engaged, they were all doing it.

However, this impact was only noted for those that participated in the project, and not all students, as this was not work that was done with other student year groups in other departments or at the school level.

Impact on students

The final part of the Science day was for students to use what they had investigated to formulate solutions to the problems the students had identified in this project. In groups the solutions were presented and voted on. Students were then asked to write a personal pledge that they could act upon. Finally, a community event was organised at the school, where the student groups of the three winning posters (Appendix D) presented their work to the CoP, and then had the opportunity to further engage and discuss their solutions within the CoP. The pupils proposed that in order to reduce clothing waste, the school should implement a second-hand uniform shop similar to online second hand retailers (e.g., Vinted); the school's site manager discussed with the pupils that such a provision already exists at the school at an informal basis (e.g. the pupils in the oldest year group are asked to return their uniforms at the end of their school year and these uniforms are then distributed to pupils most in need), but the school was worried about the stigma that such a shop might bring for pupils from disadvantaged backgrounds. However, through discussion with pupils it was clear that pupils perceive the exchange of second-hand goods such as clothing and uniforms, as common practice, as this is something they do within their families (e.g. parents selling clothes on apps such as Vinted, or having to wear their older siblings' or cousins' uniform). Giving pupils a voice during this communication event allowed school management staff to listen to and to better understand pupils' perspectives on this issue. The students' solution of a second-hand clothing shop was also supported by other CoP members attending, who commented:

the community is happy to help support them [students] with getting the school uniform bank up and running. [We're] also currently looking into the catering wastage and hopefully this will also tie in with our community pantry

According to the lead science teacher, the Science day had a positive impact on the students as it "opened up a lot of eyes and things that you would have expected them (the students) just to know, a lot of them didn't [...] I think it has certainly raised awareness of what we would consider kind of

standard things that you would know about" (teacher interview July 2023). This was supported by the students' feedback, who noted that 'I was shocked and surprised to find out about the amount of food waste and how much plastic [there is] in food" (Student group interview 1, June 2023). The science day clearly had an impact on students, as the teacher also noted that 'a lot of them still talk about, little snippets like "we eat a credit card's worth of microplastics a year" and... little things like that have stuck, and so I think to that extent it's certainly had an impact' (teacher interview, July 2023).

Students valued the opportunity to have their voices heard as active members of their community instead of passively allowing adults to make decisions for them, as pointed out by one of the students during the second round of group interviews:

> *It was quite fun because we got to express our viewpoints on waste management with adults and teachers so they can understand how we feel about it as well, which is quite interesting because we get to get involved with that kind of thing instead of waiting for the teachers and staff to do it themselves (Group 4 Interview, June 2023).*

> *we got to think of our own solutions to problems not like in science [lessons] where we learn facts. Thinking for yourself is more like being a scientist." and that it was "Good to understand what is going on and how we take the solutions forward (Group 1 interview, June 2023)*

This shows the students were engaged with the topic and that their solutions and outcomes of this work are being taken forward by the school to improve their waste management practices.
School leadership was supportive of the COSMOS approach, and became members of the CoP formulated (although a peripheral member). For example, senior leadership members attended the SSIBL Science Day to observe the activities and talked with the pupils about what they were learning.

At the end of the SSIBL Science day, they said that the SSIBL-CoP implementations were
"exactly the sort of excellent education that we want here at [School name]; meaningful; complex; real... and developing [the school's] core skills of future leadership & ethical global citizenship - ultimately preparing our youngsters to rise to the challenges of their future..."

Further, the Headteacher and the Head of the Science Department, attended the presentation event at the end of the SSIBL-CoP implementation, discussed with the pupils their proposed solutions and

pointed out the importance of such activities for impactful learning and citizenship development. The school leadership's presence was an encouraging sign for students who noted that 'now we have learnt about it and presented to SLT [senior leadership team], it seems more likely that the school might do something". However, when asked whether they thought they were making a difference through their actions, students points out the importance of collective action for impactful change, but they remained positive noting that a good starting point would be communicating and advocating for action: 'if we start telling people about it, more people can get involved and more people will the more people get involved and that's how we can make a difference" (Group 1 interview, June 2023). A way to get the students onboard with this type of project in the future, would be for the school to make sure some of their suggested actions are seen to be happening to support students' confidence in their capacity for change within their communities.

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2.7. Global Analysis of Round 1 Case Studies

The COSMOS approach offers a transformative model for education, focusing on integrating inquiry-based learning with real-world socio-scientific issues (SSIs). While it has shown immense potential to enhance student engagement, foster community collaboration, and address pressing societal challenges, the project's implementation has faced notable difficulties and challenges. A comprehensive evaluation of the COSMOS project reveals both its potential and its obstacles, as well as strategies to address these challenges effectively.

Potentialities of the COSMOS Approach

1. Promoting Active Student Engagement and Ownership

The COSMOS approach has proven highly effective in fostering active student participation and ownership of their learning. Students are empowered to engage deeply with real-world issues that resonate with their lives and communities. For instance, in Belgium, students worked with local law enforcement on homelessness and park safety, learning to address local issues through inquiry-based projects. In Portugal, students explored earthquake preparedness, a topic linked to recent seismic

events that piqued their interest. These real-world connections enhance students' motivation and lead to greater learning outcomes, making them active agents in their education.

2. Enhancing Community Involvement

A key strength of the COSMOS approach is its ability to bridge the gap between schools and their communities. In Portugal, students collaborated with their families to develop earthquake preparedness kits, while in Sweden, students worked with the Alma Löv Museum on GMOs, combining scientific inquiry with art. These collaborations help extend learning beyond the classroom and integrate community stakeholders into the educational process, making learning more impactful and relevant.

3. Addressing Real Societal Challenges

COSMOS provides a platform for students to tackle real societal issues, making their learning experiences more meaningful. In Israel, for instance, the project centred on promoting healthy lifestyles to address obesity in the community. The integration of real-world challenges into the curriculum ensures that students not only learn scientific content but also develop problem-solving skills relevant to their community's needs.

4. Flexibility and Adaptability

The flexibility of the COSMOS model allows schools to tailor projects to their local contexts, ensuring relevance. In The Netherlands, schools focused on air pollution and particulate matter, aligning with local environmental concerns. This adaptability ensures that the COSMOS approach remains responsive to the specific needs and interests of students, teachers, and communities, providing a highly customizable learning experience.

5. Collaborative Learning Communities (CORPOS)

A core component of the COSMOS approach is the creation of CORPOS (Collaborative Research, Practice, and Outreach Spaces), which bring together teachers, external stakeholders, and higher education institutions (HEIs). In Sweden, for example, CORPOS facilitated collaboration between schools, museums, and universities to implement a GMO-themed project. This collaborative structure enriches the learning process, allowing for the sharing of resources, expertise, and ideas across institutions, thus enhancing the impact of educational projects.

Challenges of the COSMOS Approach

Despite its benefits, the COSMOS approach also faces several challenges that can hinder its successful implementation:

1. Time Constraints and Teacher Workload

A common challenge across multiple case studies is the additional workload teachers face when implementing COSMOS projects. Teachers in The Netherlands expressed difficulty balancing SSIBL (Socio-Scientific Inquiry-Based Learning) activities with their regular duties due to an already overloaded curriculum. In Portugal, teachers struggled with time constraints, further complicated by national strikes. This burden can lead to burnout and reduced enthusiasm for long-term participation.

2. Sustainability of Collaborative Networks (CORPOS)

Maintaining the sustainability of CORPOS is another challenge. In Belgium, while initial enthusiasm for the project was high, sustaining regular collaboration among teachers, external partners, and community stakeholders proved difficult. Similarly, in Sweden, the lack of local organisations related to GMOs limited the network's expansion. Collaborative structures that rely heavily on a few individuals are vulnerable to losing momentum without long-term institutional support.

3. Institutional and Cultural Barriers

Resistance from institutional structures and cultural barriers can obstruct the COSMOS approach. For instance, in Israel, although there was strong community involvement, teachers faced difficulties integrating inquiry-based learning with their existing curriculum. Similarly, in Sweden, the school struggled with engaging parents due to language barriers and cultural differences. Addressing these barriers is essential for ensuring broader participation from all community members.

4. Pedagogical Adjustments and Learning Curve

Transitioning from traditional teaching methods to the SSIBL pedagogy requires significant adjustments, which many teachers found challenging. In The Netherlands, teachers struggled to balance inquiry-based learning with their national exam preparation. In Portugal, some teachers found it difficult to adopt the open-ended, student-centred nature of SSIBL. Supporting teachers through professional development and peer collaboration can help ease this transition.

5. External Disruptions

External factors such as strikes, political unrest, or national exams can disrupt COSMOS projects. In Portugal, teacher strikes led to the cancellation of several COSMOS activities, delaying the project's implementation. In the UK, national exams clashed with the flexibility required for COSMOS projects. Schools need strategies to ensure continuity in the face of these external disruptions.

6. Sustaining Student and Community Engagement

Maintaining student and community engagement throughout the project cycle can be challenging. In Belgium, while students were initially enthusiastic, keeping that momentum over an extended period required ongoing effort. Similarly, in Sweden, students expressed a desire for more hands-on science activities, suggesting that maintaining engagement requires offering diverse and stimulating learning opportunities.

Solutions to Overcome COSMOS Challenges

1. Mitigating Time Constraints and Teacher Workload

To reduce teacher burnout, schools should embed COSMOS activities into regular schedules, as seen in The Netherlands with their "activity weeks". Schools can also foster team collaboration to distribute workload across multiple teachers, as was successfully done in Sweden. Providing institutional support and integrating SSIBL into the standard curriculum ensures that these projects do not feel like extra work.

2. Ensuring Sustainability of CORPOS

Sustaining CORPOS requires ongoing professional development and embedding collaborative networks into the school's structure. In Israel, regular teacher professional development (TPD) sessions helped maintain the engagement of teachers and external partner. In The Netherlands, ensuring that CORPOS meetings were part of the regular school schedule helped integrate these networks into the school's fabric.

3. Overcoming Institutional and Cultural Barriers

Engaging school leadership early in the process can help overcome institutional resistance. In Portugal, school directors played an active role in supporting teachers during difficult periods. Additionally, culturally sensitive strategies to engage parents, such as holding community exhibitions or offering accessible activities, can foster better collaboration with diverse communities, as seen in Sweden.

4. Supporting Teachers Through Pedagogical Adjustments

To ease the transition to SSIBL, schools should provide targeted professional development and peer learning opportunities. In Portugal, teachers with prior experience in inquiry-based education found it easier to adapt, while others benefited from additional support. Schools can also align SSIBL projects with core curriculum objectives to balance innovation with exam preparation.

5. Addressing External Disruptions

Schools can build flexibility into their schedules to account for potential disruptions. In Portugal, the flexibility to reschedule and condense COSMOS activities helped mitigate the effects of teacher strikes. Offering alternative delivery methods, such as online engagement or hybrid models, can ensure continuity during unforeseen disruptions, as seen in Israel.

6. Sustaining Student and Community Engagement

To maintain engagement, schools should focus on selecting SSIs that resonate with students' interests and local issues. In Belgium, the focus on community problems like homelessness helped sustain student interest. Public exhibitions or events showcasing student work, as planned in Sweden, can keep the broader community involved and invested.

Conclusion: A Balanced Evaluation and Path Forward

The COSMOS approach offers substantial potential to transform education by linking scientific learning with real-world issues, fostering student agency, and enhancing community collaboration. However, to fully realise its potential, schools must address key challenges such as time constraints, teacher workload, sustainability of collaborations, and external disruptions.

By embedding COSMOS activities into regular school structures, providing sustained professional development, engaging school leadership, and offering flexible scheduling, these challenges can be effectively mitigated. The COSMOS approach, when supported by strong institutional frameworks and community engagement, provides a powerful model for inquiry-based education that prepares students to address real-world challenges.

3. The Case Studies of Round 2

Each partner developed one case study during each implementation round, centred on a particularly interesting COSMOS implementation in their country. The case study was focused on the progression of a Community of Practice (CoP), beginning with the context in which it was proposed and describing the different phases of its development. It was presented as a narrative or story, rather than a list of points, with the topics outlined in the guidelines serving as a list of points to be addressed within the narrative. This approach ensured that each case study addressed the same aspects of the implementation. The case study was prepared by each country's COSMOS team using the information collected through the already conducted focus group and teacher interviews.

According with the provided guidelines , each case study mentioned several key topics. In addition to the aspects already requested for Round 1, some topics were added related with Teacher Professional Development (TPD). It began by describing how the professional development was conducted, including the overall structure of TPD activities and the order in which they were organised around COSMOS conceptual components. It also explained how TPD addressed the three key components of COSMOS—Learning in/as a community, SSIBL-CoP, and Reflection—detailing both the TPD activities conducted and any additional activities that were not included in the TPD handbook.

The case study then provided information on the participants involved in TPD, including who participated, such as teachers, additional school members, CORPOS members, and out-of-school community members. It discussed their extent of involvement and how they were engaged in TPD, as well as the level at which TPD was conducted, whether with individual teachers, school teams, or teams from different schools.

The study also examined how TPD was adapted to the school context, considering the cultural context of the school, relevant openness attributes at the onset of the implementation round, and the teachers' familiarity with SSIBL and other central COSMOS concepts. It described the integration of TPD with the co-design of learning units and the implementation of SSIBL-CoP, noting that this could be addressed separately or in relation to the components of implementing SSIBL-CoP learning units.

The opportunities and challenges associated with TPD were discussed, including the opportunities created at various levels—the school, staff, students, and the broader community. The key success

factors and strengths of TPD were highlighted, as well as the challenges it faced, and the strategies employed to overcome them.

The perceived impacts of TPD were also a key topic in the case study. It described the effects of TPD on teachers' competencies for developing and implementing SSIBL-CoP and community-oriented SSIBL, as well as on students' learning, the development of CORPOS, and the viability and sustainability of CORPOS. Additionally, the case study explored the perceived impacts of TPD on teachers' professional identity, particularly regarding learning in/as a community and Open Schooling in Science Education and provided evidence to support these impacts.

3.1. The case study from Belgium

Sleutelhof – a school where pupils are put first

Sleutelhof is an elementary school in the rural municipality of Rumst, located in the province of Antwerp. In Sleutelhof, they start from each child's own talents so that all children can be proud of themselves. They strive to make children feel good and that they enjoy coming to school. If that succeeds, then they are also motivated to take initiative and learn.

Sleutelhof is...

... an open school

Everyone who subscribes to the vision of Sleutelhof is welcome. There's lots of green in the school and there are spacious classrooms. They are very dedicated to outdoor learning. They try to shape a learning environment that facilitates active play and learning outside of the classroom.

... a warm school

Pupils come always first in Sleutelhof. They have a solidly based special needs policy both for living as for learning. In this school pupils play together, learn together and grow together. A team of teachers cares for pupils, themselves and each other. There is also an active parents' council that annually organises activities to bring parents together.

... a school in movement

In the pupils' council, pupils think about the organisation of their school. The teacher team coaches pupils to develop their talents and shape their education, supported by their parents.

... a safe school

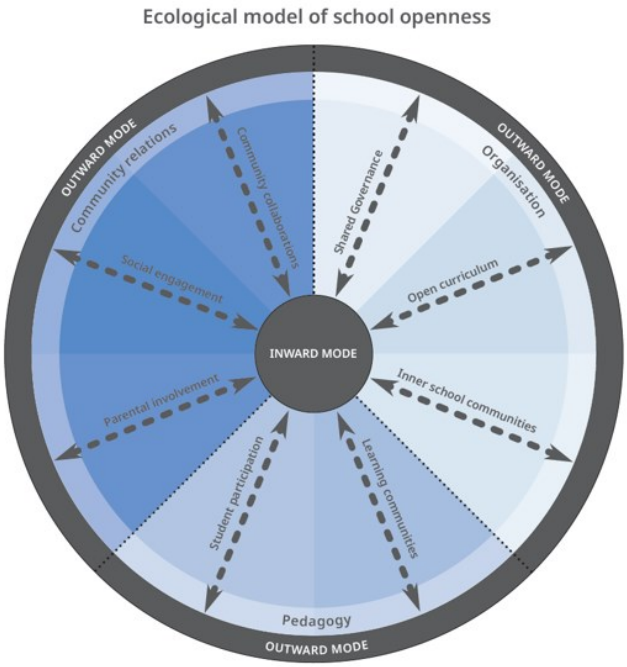
The Sleutelhof team puts a lot of effort into creating a safe school environment. On one hand there's time for traffic education what ends up in a pedestrian and bicycle examination. On the other hand

pupils are allowed to make mistakes. They are taught to act or react correctly by engaging in connection and healing.

Sleutelhof. (2024). Ouderboekje. Welkom in het Sleutelhof – Een basisschool voor instappertjes tot en met zesdejaars. https://2020.sleutelhof.be/op-onze-school/onze-visie/

The Sleutelhof CORPOS – The ultimate stretch in busy schedules

Within the COSMOS project the CORPOS of the school consists of one Year 4 teacher, one Year 5 teacher, two Year 6 teachers, two pedagogical advisors from the educational organisation Djapo and three teacher trainers and researchers from Karel de Grote University of Applied Sciences and Arts (KdG).



The CORPOS pinpointed three of the eight COSMOS openness dimensions as the bigger picture for implementing SSIBL-CoP: more (and more meaningful) student participation, more parental involvement and more community collaborations. In the beginning of the school year, regular coaching session were scheduled to start exploring the aims and added value of the COSMOS project. Afterwards the whole CORPOS attended the teacher professional development in Prague where the pieces of the COSMOS puzzle fell together for the teachers.

Toward the actual project about ecological footprint the CORPOS started working on demand of the teachers because of daily school reality and the habits of the teacher team to work very last minute. At the end of the implementation the school leader joined the CORPOS. She was highly motivated - along with the Year 5 teacher - to sustain the effort and knowledge of the COSMOS project in the whole school by implementing the school openness wheel exercise with all the school staff and implementing the SSIBL-CoP pedagogy into the daily teaching life.

Community of Practice – Flexibility as the key for stability

The initiation of the Community of Practice, started from the same existing consultation structure of the Year 4, Year 5 and Year 6 teachers, Djapo and KdG. As an SSI, it was – after the teacher professional development in Prague - jointly decided to focus on lowering the ecological footprint of the school.
As the teachers were convinced to increase student participation within the project, they decided to let the pupils themselves identify possible, valuable partners for the project. The search for valuable external partners became therefor the responsibility of the pupils.

During the design of the SSIBL-CoP, we worked in different steps: intake – kick-off – workshop – consultations – reflection & evaluation. The theoretical input we provided to the schools was the following: SSIBL-CoP, didactics to explore, investigate and take action on socio-scientific issues, formulating a good research question … Collaboration with the teachers was strongly based on the needs of the team. Coaching moments or consultations with KdG and Djapo were not scheduled in advance to meet the expectations of the teachers.

SSIBL-CoP implementations

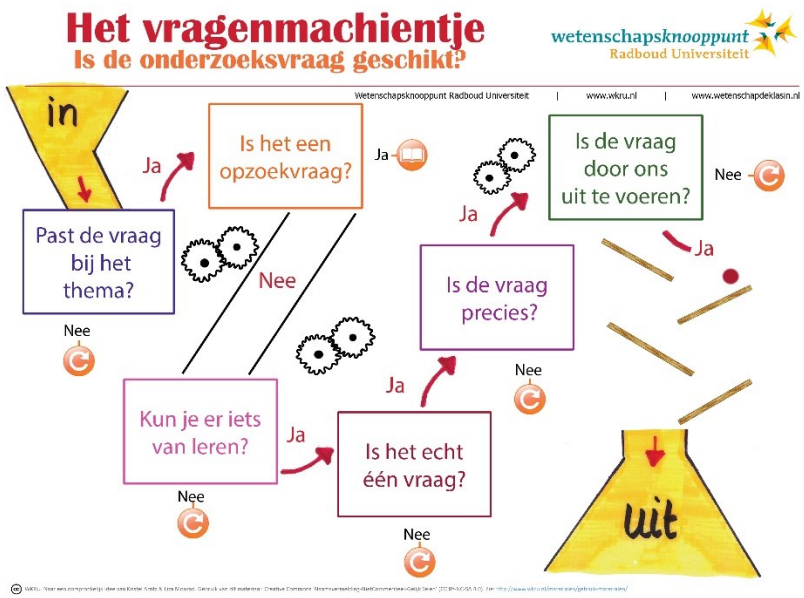
At the start of the process of designing the SSIBL-CoP, the teachers brainstormed with the pupils about their prior knowledge about the ecological footprint by using the method 'Kaas met gaten'. On a picture of a cheese with holes, students wrote in the cheese what they already knew and in the holes what they did not yet know. They exchanged with each other to fill in the holes already a bit more or noted something down in new holes.

To get to know the topic of the ecological footprint a little bit better, the teachers executed a short roleplay to introduce the subtopics: sorting waste, food waste, packaging, the use of electricity, biodiversity, 'lost stuff', transport, saving water and heating the school building. Afterwards the pupils conducted a survey on their own ecological footprint.

At the end of the introduction phase, the pupils chose a subtopic of their preference with the method 'The Pyramid'. Each pupil had a pyramid with different levels. They located the subtopics in the different levels: in the top – the most preferred subtopic, below – the less preferred subtopics. They needed to explain why they were (not) attracted to the different subtopics. Based on these pyramids (and group dynamics), the teachers divided the group into different subgroups. Across the 4-week project (6 hours a week), pupils were then given the opportunity to work on this subtopic of their choice.

ASK

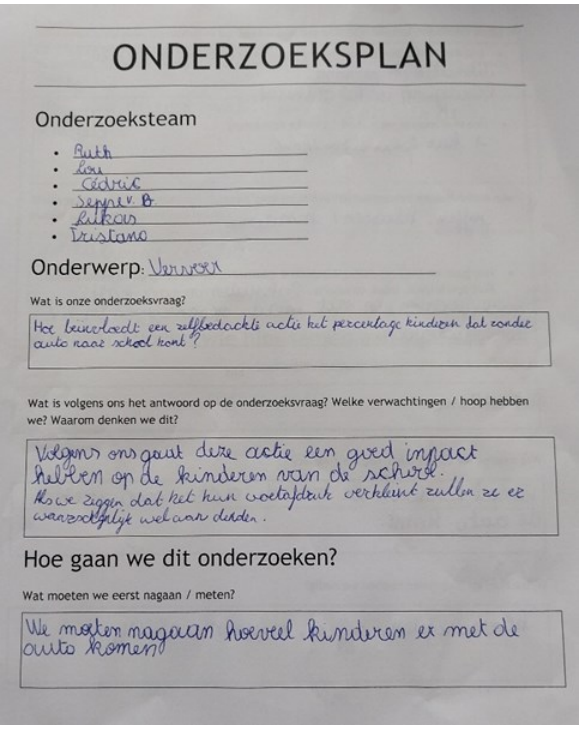
In this phase, the pupils got to know the subtopic a little bit better by executing a first search on the internet and in books (supported by guiding questions of the teachers). Afterwards, they tried to define their key research question by using the 'Vragenmachientje from the Radboud University in The Netherlands.[2]



[2]https://www.ru.nl/wetenschapsknooppunt/materialen/leerlijn-onderzoeksvaardigheden-po-vo/hulpmiddelen-per-onderzoeksvaardigheid/#h91700375-f8b9-5161-e7be-fae7d3ad5587

FIND OUT

To answer their research question, each group of pupils does a pre and post measurement. In between, they execute their action.



ONDERZOEKSPLAN

Onderzoeksteam

- Ruth
- Lou
- Cédric
- Senne V. B.
- Lukas
- Tristano

Onderwerp: Vervoer

Wat is onze onderzoeksvraag?

Hoe beïnvloedt een zelfbedachte actie het percentage kinderen dat zonder auto naar school komt?

Wat is volgens ons het antwoord op de onderzoeksvraag? Welke verwachtingen / hoop hebben we? Waarom denken we dit?

Volgens ons gaat deze actie een goed impact hebben op de kinderen van de school. Als we zeggen dat het hun voetafdruk verkleint zullen ze er waarschijnlijk wel aan denken.

Hoe gaan we dit onderzoeken?

Wat moeten we eerst nagaan / meten?

We moeten nagaan hoeveel kinderen er met de auto komen.

They start with a personal inquiry: What do we feel/think about the issue? Depending on their subject, afterwards they did a social (f.e. interview with teachers and the principal) and/or a scientific inquiry (f.e. measure the different species in their school garden).

Each group of pupils needed to involve at least one external partner to help them find an answer to their question. Due to some very last minute work of the teacher team and the limited guidance given to the students in this regard, the actual collaboration with these partners was rather limited.

F.e. local supermarket, local garden centre, parent who works as an electrician, a police officer …

ACT

After their pre measurement each group invented an action to execute within the school and contribute to a lowered 'ecological school footprint'.

F.e. motivate pupils & teachers to use the small button to flush the toilet instead of the big button – plant more biodiversity-friendly flora on the playground – make the 'lost stuff' more attractive – add an extra garbage bin for reusable paper - …

Two weeks after the start of their action, they did a post measurement.

At the end of the project, they presented their subtheme to the whole school: pupils, teachers, the principal, parents, the societal partner, the higher educational partner …

Reflections on this case

Before we started the project, the societal partner – Djapo - initially only had contact with the principal. When talking to the teachers the first time, it became clear that it wasn't their choice to participate in COSMOS. Nevertheless, from the beginning on, they were very much willing to learn from the project but there was a mismatch between what we thought they knew about the project and what they actually expected. It took us until the teacher professional development in Prague to overcome this challenge and talk and think on the same line.

To establish the CORPOS and CoP, we needed to be very flexible. The project team is used to work very last minute and expected us to be very available on an ad hoc basis. We managed to meet the needs of the team, but we believe – regarding the COSMOS project aims & learning process of the students – we could've reached more when we were able to guide them on a more regular basis and with a good preparation. Being very flexible in working with schools seems very important and necessary. But we need to find a balance between being flexible and asking some minimal efforts and engagement when participating in a project.

The project was built on a lot of pupil initiative and participation. We know this can be very educative, but the build-up towards this type of education was lacking. The children were very clear that they missed support in how to do (social or scientific) research and how to involve external partners within a project.

The principal was the initiator of the participation of the school in COSMOS. Afterwards she disappeared until the day where the students presented their projects. After the end of our guidance within the school, she explained that she's willing to implement the SSIBL-CoP-pedagogy into the whole school to encourage all students to grow up to critical and hopeful adults.

Focusing on improving school openness and implementing SSIBL-CoP pedagogy requires minimal experience and expertise from the participating teachers in scientific education and inquiry-based learning. Achieving goals in multiple of these dimensions simultaneously tends to be difficult.

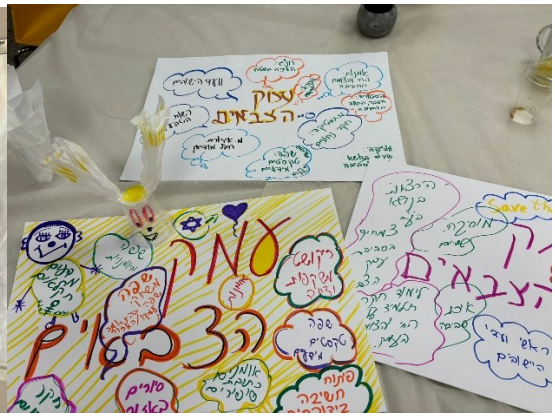
3.2. The case study from Israel

Lapid primary school (Continuing school – 2nd year implementation)

The context of the case study

Lapid elementary school is situated in a small community town (Lapid), in a primarily rural area in the central region of the country, at the outskirts of the Ben-Shemen Forest and in an environment rich in natural assets. This small school caters to some 280 students from grades 1-6. Grades 4-5 participated in the project. 100 students participated in the project.

Lapid has participated in COSMOS for two years.



Creating the CORPOS (Core ORganisational structure for Promoting Open Schooling)

The CORPOS was constructed on the basis of the previous year's CORPOS membership, which included both inner and outer school stakeholders. Inner school members included the principal, teaching staff from various school subject coordinators (science, arts, and homeroom teachers) and outer school members included Higher Education representatives (composed of COSMOS project staff), representatives of the Ministry of Education (Department of R&D, Experimentation and Initiatives), and the chair of the parent committee (who is also active in the Society of Nature).

The CORPOS members initially considered to continue working on the same SSI (socio-scientific issue) that it explored in the previous year ('The disappearance of bees' which was identified as a relevant SSI for the school community since some of its members are beekeepers), but recent developments in the area led to a change in plans: the construction of a 3-lane roadway cutting across the nearby natural habitats, threatening local wildlife and the ecological integrity of the local natural ecosystems (Cosmos project). The CORPOS convened to discuss these developments and decided to change the

SSI for the second-year implementation, focusing on the dilemmas connected to development at the expense of nature-preservation as these play out in their area including the nearby "Gazelle Valley" nature reserve.

The decision to change the SSI to one that is relevant to *the broader community (including additional towns in the area)* and reflects the mutual interests of all inhabitants of the area, was significant in increasing community participation and activism. An open meeting (knowledge event) was organised by the CORPOS for all the inhabitants in the area to share with them information concerning the implications of constructing the roadway and hear their opinions. The engagement of people living in the area, including parents of students learning in the school (which ranged from more passive agreement to more active engagement) and the choice to focus on an issue that has a direct impact on many community members' quality of life, reinforced CORPOS membership and was a strong entry point for creating the community of practice around the SSI chosen (preservation vs development).

The SSIBL-CoP process

Following the CORPOS's choice to explore the roadway SSI, a learning community was established to set the grounds for the various stages of inquiry (ASK-FIND OUT-ACT). The capacity to establish the learning community was relative ease given the preliminary involvement of the CORPOS in initiating the community (some of its members became directly and actively involved in the CoP). Equally significant was the school's collaborative organisational culture and structures: The school is well accustomed to teamwork and collaboration between students and staff and among school subjects/disciplines, and is experienced in shared decision-making processes, which is actively supported and promoted by the school principal. Given the communal nature of Lapid as a rural community town, parents in general, and parent committee members in particular, are involved in school activities and are regularly invited to take part in decisions regarding various aspects of school learning and projects. Not all parents are cooperative. Some try to enforce their perspectives on school leadership. Yet, on the whole, this is a tradeoff that the school is willing to accept since in most cases parents and the school share mutual interests and the school identifies the parents as important agents in its educational efforts. This collaborative culture also impacts the school curriculum; while the teaching staff follow the national curriculum, they are, nevertheless, able to be flexible in terms of applying the curriculum with regards to both learning contents and teaching methods. Teachers are encouraged by school leadership to bring their own initiatives, students (especially the student council and student leadership) have a voice and make choices/take part in decision making regarding certain aspects of their learning. There is an acceptance of diverse ways to teach and learn along the

traditional-to-innovative teaching continuum. Nevertheless, the experiences of the previous year in implementing the COSMOS approach contributed significantly to enhancing the school's openness, and this pertains particularly to the school's interest in social engagement, namely, the conscious effort to address social problems and issues, and the idea of collaborating with the community and external stakeholders has become more deeply ingrained into the school's vision and practices.

The first steps taken were dedicated to creating a network of dedicated stakeholders who also have expertise and knowledge in the topics related to the newly chosen SSI. The co-design process, with the participation of teachers (from different disciplines), parents and environmental professionals and activists, started by organising field trips and outdoor activities to consolidate a community around the SSI. The active participation of parents in the fieldtrips and activities contributed to engaging the community with the SSI. One of the parents guided a fieldtrip to the areas destined for development (road construction), and a former SPNI (Society for Protection of Nature in Israel) instructor volunteered to take part in guiding additional outings. An environmental activist the school was acquainted with became an active participant in all activities, including supporting the social networking via Facebook around the SSI. Building on existing connections with professionals and community members was key in promoting initial learning of the complex issues involved. The teaching staff conducted a 'stakeholder mapping' in which they identified potential-possible community members (including parents, professionals from within the community, and external organisations), evaluated the interests and abilities of each stakeholder group in order to understand how to integrate them productively within the learning community. Then WhatsApp groups and e-mails enabled ongoing updating and coordination of activities. Periodic meetings were conducted regularly, Face-to-Face and online, enabling ongoing updating regarding the situation, sharing experiences and ideas, and planning the next steps.

The fieldtrip and other outdoor activities provided both students and grownups that were invited to take part the opportunity to learn about issues of urbanization and development and witness, first-hand, the threats to the environment and the natural assets that would be affected by the development (Pre-ASK). Different outdoor activities included playing games in the natural environment, preparing art works from leaves, making drinks and different remedies from the natural flora. All these activities served to create a connection to nature and understanding of the importance of protecting it. They learned about the Israeli Gazelle and the importance of protecting its habitat. At school, workshops for teachers, parents and students were conducted to provide the knowledge foundations related to environmental activism and nature protection. The children also learned in

small inquiry groups about the local flora and fauna and develop mindful opinions on the environmental-social issues and dilemmas involved in this controversial issue. These learning experiences gave rise to the formulation of different questions (ASK) regarding the SSI and developed critical perspectives and inquisitive mindsets. For example, how will the roadway impact wildlife in the area? What are the ecological and environmental impacts of constructing the roadway? How will noise and air pollution impact the quality of life of people who live in the area? Are there alternatives to paving the roadway? How can we influence the decision-makers and prevent the construction of the roadway? These questions served the basis for inquiry and exploration.

Some of the inquiries (FIND OUT) were conducted in situ as part of the fieldtrips, some in dedicated workshops in school and some in classes in different subjects (science education, arts, literature, homeroom classes) that connected the learning to the SSI. Several themes were discussed as part of the ecological inquiry: micro-climate, plants and wildlife. The students learned how to measure and analyse temperature and humidity data, and how to document species diversity, they measured noise levels and concentrations of several air components and compared data collected from different areas.

A social inquiry activity was conducting a survey and interviews with the local residents to explore their attitudes concerning the SSI and its potential impacts. They conducted statistical analysis of the survey data. Parents with suitable backgrounds helped in preparing the survey, conducting the interviews and analysing the data. The students then chose a specific topic and prepared, with the assistance of their parents, presentations for peer learning and discussion after collecting information from the internet, including scientific articles and papers. The outcomes of the learning process were documented as part of reports and assignments given to the students. These inquiry findings were communicated by students through social media and in the school newspaper/newsletter. A dedicated open forum was created on the school website to enable discussions and share ideas about the project.

Various activities conducted as part of the inquiry (FIND OUT) stage, can be regarded as activism (ACT) stage activities. For example, conducting the survey is a way to promote awareness and disseminate activist ideas. Another example was the meeting that was organised by a representative of the environmental quality department of the local municipality between students and representatives of the local municipality, in which discussions were held about the construction plans and their impacts; questions were raised regarding the decision-making process (towards thinking how they can have

impact on this). Yet, the learning process included distinctive ACT stage activities such as when the students and parents prepared and distributed a signed petition against the roadway construction plan and also organised public demonstrations. The petition generated more public pressure on the decision makers, enhanced awareness around the issue and contributed to maintaining ongoing connection and participation around it. Periodic meetings were conducted for updates regarding the situation and to share experiences and ideas. Continuous communication was maintained via WhatsApp groups and e-mails.

Discussion: Strengths, opportunities, success factors and challenges

The CoP established around the 'development vs preservation' SSI, which included some CORPOS members, was successful in various aspects including creating student and community awareness of the issues addressed as part of the learning, the ability to influence public opinion regarding environmental issues, and engaging in meaningful community collaboration towards preserving nature and quality of life in the region. Student engagement and participation was particularly meaningful and led to the development of various learning skills, including critical thinking, scientific reasoning, action competences and the motivation to be active in social change processes, and the development of values of active citizenship and social activism.

Success in the above themes can be attributed to several factors. The first is the ability to create ***meaningful communication and broad cooperation with the community***: Facilitating communication among the various stakeholders (school staff and students, parents, local municipality, environmental professionals and activists) was promoted by utilising digital platforms (mainly Whatsapp and Facebook) as a means of communication, information sharing, updates and coordinating actions.

Additionally, periodic meetings that were held in school with parents and other community stakeholders for information sharing and reaching decisions contributed to coordinating learning activities and actions. The knowledge that was brought into the learning from the outside, by external stakeholders and professional such as from the SPNI, HE institutions, and local municipality representatives, enhanced the knowledge base and thus the learning experience. The use of communication materials, such as short videos and interactive materials contributed to creating awareness and encouraging involvement.

Additionally, the SSI selected is an ***authentic issue*** that interests many community members. This also served important for engaging students in the learning, making them more deeply and authentically

involved in the learning, which contributed to educating these youth for environmental-social activism and transforming them into active partners and influencers in the community. The ***flexibility of the curriculum*** and ***adapting teaching and materials*** to the individual needs of the learners was key in facilitating motivation, engagement and better uptake of relevant knowledge and development of skills. For example, outdoor learning activities, coupled with the involvement of parents, professionals and external stakeholders, sent the message that the learning is significant for the entire community and for its benefit, and this has a connecting-engaging quality.

Nevertheless, this was a complex process which required significant time and efforts towards understanding and responding to the different requirements of the different partners. The first challenge was the change of SSI after one year of addressing a different SSI (disappearance of bees), which demanded familiarising with new knowledge bases and skills. ***Changing an SSI*** – even one that is authentic and timely – is a consideration that decision-makers need to account for. Managing a large and diverse community is challenging and necessitates ***accurate planning and coordination*** to maintain ongoing interest and involvement of all involved throughout the project. Additionally, given the emergent nature of the learning process, ongoing challenges ***not previously perceived*** required ongoing attention and response, which was also ***time consuming***. Closely related are ***financial limitations***; recruiting professionals to volunteer or paid participation, organising transportation for the fieldtrips and excursions, all have financial consequences. Additionally, coordinating data collection, maintaining connections with stakeholders, and stimulating the students and recruiting them for the diverse tasks (by adapting the learning to their individual needs and interests) demands time and attention resources. Moreover, addressing a burning controversial SSI and bringing it into the children's homes (including taking a position on it) demands extra sensitivity and care.

COSMOS Impact

The most meaningful impact of COSMOS on the school was the enlarged and enhanced ***social engagement*** that comes with addressing a locally relevant SSI. The aspect of learning for the community was more significantly introduced into the school, which developed students' awareness to social issues/problems and developed, in an authentic manner, responsible and active citizenship values and skills. While previous collaborations were regularly made with the community (active parent committee), and a general collaborative culture exists among the teaching staff (shared governance and decision-making), creating the CoP substantially expanded ***community collaborations*** with parents and community stakeholders (such as the municipality and environmental organisations and activists).

The idea of mapping the surrounding community for stakeholders, as part of the process of designing learning contents and methods, brought in a different modus operandi - a new way of designing learning units. The use of non-traditional pedagogies teacher oriented transmissive (such as applying surveys, going out on fieldtrips and excursions, and writing petitions) was key in enhancing the learning experience, deeply connected the learners to the SSI and developed various other learning skills – such as critical thinking, scientific reasoning, and focusing on action competences as part of the learning goals. *Together, these contributed to creating a strong and more unified community that is prepared to address future challenges more efficiently and meaningfully. This is in line with one of the central goals of open schooling – to enhance community wellbeing.*

Teacher Professional Development

Overall TPD structure: The TPD actions at Lapid School were carefully organised to align with the COSMOS conceptual components. The structure followed a developmental approach, starting with introductory sessions that revisited the key concepts of learning in and as a community and SSIBL (Socio-Scientific Inquiry-Based Learning), ensuring that all participants had a solid foundation. The sessions then moved towards more advanced discussions, focusing on the community aspect of learning, particularly how the school could foster stronger connections with the local community through learning around a SSI. Thus, TPD actions followed the three conceptual components of the TPD framework. *Learning in/as a community*: TPD sessions emphasised collaborative learning among teachers, encouraging them to share experiences and strategies for involving students and the community in the project. *SSIBL-CoP*: The activities included workshops wherein teachers co-designed learning units based on the SSIBL framework, focusing on real-world issues that the students could relate to, particularly the environmental and social significance of the 'Gazelle Valley'. Reflection:

Reflection was embedded throughout the TPD process, with regular sessions dedicated to discussing the challenges and successes encountered, allowing teachers to adapt their approaches based on feedback. Additional activities additional to the learning activities provided in the TPD handbook included professionally guided visits to the Gazelle Valley, where teachers could directly experience the local environmental challenges. This helped in contextualising the SSIBL concepts to the community's specific needs.

Participants: The professional development involved nearly all the teachers at Lapid School, including members of school management. Additionally, external community members, including local environmental activists and members of the CORPOS participated in some of the TPD sessions. Their

involvement was crucial in providing practical insights and fostering a community-oriented approach. TPD was conducted at multiple levels outlined in the TPD framework: Individual teachers received personalised support in integrating SSIBL into their specific subject areas. School teams: Collaborative sessions were held with subject-specific teams to ensure a cohesive and coherent approach across different disciplines. Individual teachers received personalised support in integrating SSIBL into their specific subject areas.

Adapting TPD to the school context: TPD was specifically tailored to the cultural and educational context of Lapid School. Given the school's prior involvement in the COSMOS project (first year implementation), there was already a strong foundation of SSIBL-CoP principles. The focus was, therefore, on deepening this understanding and expanding the scope to include broader and stronger community collaboration and social engagement. The school's location, near the Gazelle Valley, made it an ideal topic for the SSIBL project, and the TPD was designed to leverage this unique local context. TPD was closely integrated with the co-design of learning units that the teachers were implementing with their students. During the TPD sessions, teachers worked together to develop these units, ensuring that they were not only theoretically sound but also practical and relevant to the students' lives. This integration was particularly evident in the way teachers applied SSIBL-CoP principles to the public campaign for the Gazelle Valley, using it as a live case study for their students.

Opportunities and challenges: TPD created various opportunities and at different levels. At the school level, it strengthened collaboration among teachers, leading to a more cohesive teaching strategy. At the staff level, it increased confidence in using SSIBL and Open Schooling methodologies. At the community level, it enhanced relationships with community members, providing the students with authentic learning experiences.

There were various keys to the successful application of TPD processes in school. One of the success factors and strengths was ***prior experience*** working with the COSMOS project, which provided the school a strong starting point. The ***existing collaborative organisational culture*** provided a strong basis for learning and working collaboratively with both internal and external stakeholders. The principal had a central role in setting the right climate for TPD sessions and facilitated positive attitudes toward professional development by actively supporting and participating in TPD sessions. The involvement of external community members (especially parents) added real-world relevance to the TPD.

Nevertheless, some challenges were experienced. The school, its staff, and students faced significant challenges due to the ongoing war and ensuing emergency situation, which initially made it difficult for them to engage, physically and emotionally, in serious TPD processes. However, the COSMOS project was considered as a platform/framework that provided support and focus during this challenging time. Additionally, the school was undergoing a transitional phase due to a merger with another school. This process was challenging for both the school administration and teaching staff. Yet, the professional development and participation in the project played a crucial role in helping them navigate and overcome these substantial challenges.

TPD impacts - The TPD had some key impacts. First, teachers demonstrated ***improved competencies*** in designing and implementing SSIBL-CoP projects. Their ability to integrate community-oriented issues into their teaching was particularly enhanced. The ***students*** showed increased engagement and understanding of the environmental and social issues surrounding the Gazelle Valley, reflecting the effectiveness of the SSIBL approach and thus the ability to design and implement appropriate learning units. The collaboration with ***CORPOS members*** was strengthened through TPD sessions, ensuring the sustainability of the partnership and the viability of future Open Schooling projects.
The TPD had a significant impact on the teachers' professional identity, particularly in terms of their role as ***community educators***. The focus on learning in/as a community and Open Schooling in Science Education helped teachers see themselves as facilitators of community-
based learning, rather than just conveyors of knowledge. This shift in identity was supported by the evidence of successful project implementation and positive feedback from both students and community members.

This detailed reflection on the TPD process at Lapid School highlights the importance of context-specific professional development that is deeply integrated with the implementation of innovative educational practices like learning in and as a community, SSIBL and Open Schooling as a broader educational approach.

3.3. The case study from The Netherlands

School context (new school)

The school 'Academie tien' has a citizenship aspect in their motto 'While learning changing your world' and are open to Open schooling projects and had some already running. This school has been around for about 10 years, they use no textbook, are constantly working on the curriculum and designing their own teaching materials for the various school layers.

The school organisation is very bottom-up with shared governance; responsibility is delegated. The school is organised in units for lower and upper secondary education. The lower-secondary units consist of at least one teacher of every school subject. Together they decide and develop school pedagogy and materials. The upper-secondary units are organised by themes such as science, humanities, they work with overarching 'big questions' to organise the curriculum.

The school has many collaborations with the neighbourhood: a learning community is established with a local primary school, they collaborate with teacher education institutes facilitating in-school pre-service training,and organise 'Community Collaboration Days' for their students (e.g., students cleaning up the park and build paths, walking with elderly people in care homes in the neighbourhood). A local youth counselling service is embedded in the school building and they have an active student board.

The school as a whole is on the outward spectrum of all dimensions of the Openness wheel. From the perspective of science education some dimensions are more inward, such as 'Community collaborations'.

Description of COSMOS implementation

At this school we worked in the CORPOS with three staff members from HEI and one science teacher who was the coordinator of 7 science teachers. This teacher coordinator informed the other teachers and the school manager. As the school is very bottom-up in organisation with shared governance, the teacher coordinator and manager saw no need for a representative of school management in CORPOS. Many innovative projects are ongoing at the school in collaboration with teacher training institutes or education departments of universities or other organisations. This is also one of the reasons that the teacher involved could not find another science teacher willing to participate in the CORPOS.

Biweekly meetings were scheduled with the HEI partner(s) since November 2023. Topics were process management, and co-development of teaching materials according to the SSIBL approach with specific focus on expanding the scientific inquiry to societal & personal inquiry (including assessment tools). The teacher also participated in the two-day TPD event organised by COSMOS in Prague (14-15 November 2023).

In relation to the CoP, the school already participated in a citizen science projects on Pigeons in the city, with societal partners from two different institutions:

1. A research group on animal-human relations of Utrecht University (UU): mutual benefit (expert provide info to students; students collect data: count Pigeons in city areas) and send it to the scientists.
2. The research museum UMU (societal partner): mutual benefits (the school visits UMU for free as part of the module, the UMU can add a new school to the network of schools)

There was one (hybrid) meeting with all partners involved, other meetings were with parts of this group depending on the topic on the agenda: the organisation of the museum day or the development of the teaching and learning materials.

In the citizen science project students gathered data on the colours (different species) and number of pigeons in different places in the city (and shared this data with Utrecht University's research group). This was embedded in a learning trajectory on how to conduct valid scientific research. Within the COSMOS project, the educational objectives were extended to include learning how to research an SSI and the SSIBL approach was applied to the whole learning trajectory. Students developed their own SSI-related research question (e.g. '*What do people think of the pigeon?*') and interviewed different stakeholders such as tourists, local shops, local residents. Based on their results they wrote an advice to the municipality (ACT) how to deal with the pigeons in the city. The whole learning trajectory included a kick-off of half a day at the museum, 14 lessons at school and half a day of data collection on site (counting number and different species Pigeons; interviewing stakeholders) over three months (April – June 2024) for all grade 7 and 8 students (n=430). (See for more details Table 2 below)

A kick-off day of the project was held at the UMU Science Museum. Students learned about scientific and social inquiry, and an interactive lecture of the UU researcher made students think about various historical and cultural perspectives on the relation pigeons-humans.

Table 2. SSIBL – CoP implementation with grade 7 in a new secondary school in The Netherlands. Theme: Pigeons in the city.

SSIBL dimension	Description	Duration Total: 24 hours
ASK	During a day at the science museum students learned about inquiry in the past and current research on science and social subjects, using different techniques. A researcher on animal-human relations from Utrecht University provided a lecture at the museum. This led to students' own questions in relation to the occurrence and number of different pigeons' species in the city, and question in relation to the various stakeholders of pigeons in the city (e.g., (dis)like of many pigeons in the city of local inhabitants, tourists etc.) All societal (research group UU, UMU) and HEI partners participated in developing and executing the start day at the museum.	Half a day + 1 lesson. 5 hours.
FIND OUT	In this part of the learning trajectory science teachers coached the students in developing valid research questions and learned gathering data from reliable sources and how to gather experimental data. Students first performed the scientific inquiry and then the societal inquiry (using own research question, so the personal inquiry was interwoven). Students collected data on site (Utrecht city), counting number and occurrence of different Pigeon's species (scientific inquiry) and interviewing stakeholders such as local residence, tourists, bakers in the neighbourhood (social inquiry) on their appreciation of pigeons in the city. The learning trajectory and additional materials for students were developed by the teacher coordinator in collaboration with the HEI partner. The experimental data on the occurrence of pigeons in different parts of the city, was sent to the societal partners from the research institute.	10 lessons + half day research on the street. 15.5 hours.
ACT	Students wrote an email to the city council with an advice in relation to pigeons in the city based on their social & scientific inquiry. This was part of their personal inquiry.	3 lessons. 3.5 hours.

Teacher professional development

TPD activities were organised with the CORPOS around the three conceptual components (learning as a community, SSIBL-CoP, reflection), explaining the process and concepts but not using terminology such as 'CORPOS and CoP' and embedded in examples of Dutch and regional SSIs. Biweekly one-on-

one sessions with HEI-partners and the science teacher were organised to co-develop the teaching and learning materials according to the three phases of SSIBL (ASK, FIND OUT, ACT).

Activities were adapted/flexible based on the wishes and needs of the science teacher, which mainly concerned the adequate implementation of social and personal research in the FIND OUT phase and the inclusion of a (for students meaningful) ACT phase. In addition to these one-to-one co-design sessions, the teacher participated in the two-day TPD workshops (TPD2) organised by COSMOS in Prague (November 2023).

One session was organised at the research museum UMU (societal partner) with CoP members (scientists, UMU teaching staff), for practical fine-tuning and clarification of the SSIBL approach in the module.

Participating in the COSMOS project contributed to the process of teacher professional learning, and SSIBL-CoP teacher identity development. The teacher internalised social and personal inquiry next to already existing expertise on scientific inquiry and grew in developing the ACT phase. Raising student questions is already part of the school's pedagogy, but SSIBL pedagogy made the teacher include an ACT phase and social inquiry in the FIND OUT phase.

It stressed once again what was important to her: *'the inclusion of social inquiry (humanities) in science education, and an ACT Phase that shows students the relationship with their everyday lives (and the impact they can have), and SSIBL pedagogy is the way I learned it'*.

The teacher says she will continue to use this approach (and redeveloped 'pigeon unit') and has extra lessons per week next school year, so she can make this happen. Although, she thinks this (including social inquiry) is more natural for biology teachers than for other science teachers (chemistry, physics).

> *'Well, look the ACT phase. I find that very interesting, because I think students feel so little ownership of the world, little influence, and it's really nice to do something that they, that they can actually make something and possibly change something in the world. So that is, I really like that, because that is something we don't think about very often or so while it is very important.' [N2A2, 63-67]*
>
> *'I felt beforehand that we should be more social and it has actually confirmed that I really like it. That's really cool because I mean we, our students. We are, education and big questions, school of humanities and if then as a STEM education, you don't have that really humanities, of course that's super a shame and while our students were actually really good at it, because they all went out in the end and they still took that*

that step of addressing someone they didn't know. That's actually really nice to see' [N2A2, 167-173]

'Social science research, so doing something where students actually go out and interact with people, about STEM education or about STEM, because that that I mean, [...] I personally notice with many students that STEM education is sometimes a bit of a distant concept, because they don't really see how it affects them yet. So all very nice to talk about those food chains, but what do I have to do with that? [...] so I think STEM I notice with students that it's harder for them to see how they have an impact and how what they do affects them. And I think that with social research like this, you're going to hit that, I hope, I think.' [N2A2, 299-310]

Reflective remarks

There were less collaborations with stakeholders than the teacher wanted: it is more difficult to link with scientific organisations than with societal organisations since there is less benefit for these institutes in collaborating with the school:

'A lot of social enterprises are very much towards us [the school], they want to come to us. But for a STEM institute, what can we bring?' [N2A2, 360-361]

But the science education section showed now (through this project) that they also can contribute to these dimensions. The collaboration with the scientific department of Utrecht University and the science museum works since there is a mutual benefit (scientists give lectures for the students, university gets the data of the pigeon counts).

In the slipstream the dimension ***Student participation*** was moving outwards: the SSIBL-CoP module provided a lot of room for formative assessment – feedback from students and adapting activities and lessons based on students' feedback and questions. Especially the social inquiry, in which students interviewed different stakeholders in the city (can be considered a SLE), students and teacher indicated that they learned the most: *'daring to interview people on the street, formulating adequate interview questions'*.

The SSIBL-CoP unit was woven into the regular curriculum for a longer period of time ('Add-in'), including an assessment activity at the end of the unit, which seems to be more sustainable. The SSIBL-CoP module will be part of next years' curriculum too, even with extra lesson time, so the open schooling approach will defuse over time.

According to the teacher the SSIBL-CoP approach with special emphasis on social inquiry and social engagement (through ACT phase) in the context of science education, will be more viable and sustainable when implemented in the school vision document.

3.4. The case study from Portugal

The Context

In Portugal, schools are organised in clusters: groups of schools from different levels of education that function under the same directive board and develop a common pedagogical project they consider adequate for their social and cultural reality. This case study is centred in the collaborative activities developed by the "Romeu Correia" School Cluster, represented in COSMOS by one primary school and one secondary school. Sometimes it is hard to individualise the work developed in each educational level because of their collaborative nature. "Romeu Correia" school cluster is in Lisbon outskirts. This school cluster is participating in COSMOS for the second consecutive year. However, the addressed SSI changed from last year.

This case study is centred around the 2023-2024 school year, corresponding to the 2nd round of COSMOS' implementation.

The CORPOS

The CORPOS was developed in the "Romeu Correia" school cluster and not in each school. Decisions were made by consensus between all the CORPOS members. The CORPOS participants were one IE-ULisboa professor, one societal partner from "Ciência Viva", two primary school teachers (one of them in charge of the library) and one secondary school teacher. The school cluster's director was not directly involved but entirely supported all the implemented activities and initiatives, delegating the authority to the teachers to decide on their participation/involvement in COSMOS.

One of the CORPOS members is used to implement activism initiatives based on an inquiry-based science approach. He took both a master and PhD degree at the IE-ULisboa (supervised by Pedro Reis) about the topic of students' activism (understood as a collective and democratic problem-solving process centred on socioscientific or socioenvironmental problems affecting their communities). So, he belongs to a CoP that the IE-ULisboa has been supporting for 14 years centred on students' and teachers' activism, and the SSIBL-CoP has a lot in common with the initiatives we have been

developing. The CORPOS was developed based on the strong relations (personal and professional) existing between the IE-ULisboa team members and this teacher. In the school cluster, this teacher had a very important role in mobilising other teachers (from different levels of education) to the CORPOS. The fact that they work organised in school clusters, provided a context in which internal collaboration between different levels of education already existed.

Four significant factors played a pivotal role in the development of CORPOS within the school cluster:

- The active participation of certain teachers in the Activism Community of Practice sponsored by IE-ULisboa. The CORPOS was maintained/supported by the strong collaboration and the shared culture/interest (between the IE-ULisboa team and these teachers) in terms of the importance attributed to inquiry and activism initiatives implemented by students and teachers. This culture has been developed during a 14 years' long process of collaboration associated with a CoL centred on that kind of initiatives.
- The positions of leadership regarding pedagogical innovation and project implementation in schools occupied by those teachers.
- The attitude of the school director, sharing leadership and trusting the work of teachers. This support facilitated the integration of CORPOS into the school's activities, creating a supportive environment for innovative teaching practices.
- The presence of a "Science Club" dedicated to fostering collaborative projects involving students, teachers, scientists, members of science centres, parents, and other community members, supported by Ciência Viva – a societal partner of COSMOS.

However, several obstacles to CORPOS development were also experienced. One of the biggest challenges was the lack of time. Teachers often have packed schedules, making it difficult to plan and implement different activities. Rigid curriculum requirements and standardised testing pressures limit the flexibility needed for CORPOS, making it difficult for teachers to integrate innovative projects. Other obstacles were the reduced number of teachers wanting to participate in the project due to the obstacles mentioned before.

The contacts between the CORPOS members were established both through videoconference, phone calls to the main teachers involved and meetings in the schools by IE-ULisboa team members.

The multi-level structure of this CORPOS – with representatives from primary and secondary schools – upheld and further explored the tradition of Portuguese school clusters in terms of collaboration between education levels, with the aim of developing shared pedagogical projects they consider suitable for their social and cultural context.

The Socio-Scientific Issue (SSI)

The SSI for the SSIBL-CoP was chosen during a brainstorm session in Prague COSMOS meeting between the CORPOS' members from both Portuguese School Clusters. Then, they decided to focus on sustainable buildings (e.g. sustainable school building and sustainable homes), with the aim of creating a sustainable project that could engage students across different educational levels and allow the collaboration between the two Portuguese School Clusters. Later, in this school cluster, the initial proposal from Prague was reworked to align with the specific context and needs of the schools in Almada. Upon returning from Prague, the educators realised that the original theme did not fully resonate with their students or address the immediate issues within their school environment.

Therefore, they shifted focus towards practical improvements within their own school, using the theme of "the school of the future" as a catalyst for identifying and addressing current challenges.

This SSI allowed the synergetic collaboration between projects and resources proposed by different institutions: the COSMOS project proposed by the IE-ULisboa and Ciência Viva; the "Science Club" proposed by Ciência Viva; the project Agenda 21 from the City Hall.

The Community of Practice (CoP) and the Implemented Activities

A CoP was created to support the SSIBL implementation about the chosen topic. Some characteristics of the school cluster facilitated the CoP development: 1) some level of teachers' autonomy in adapting the curriculum for the incorporation of dimensions – topics, skills and attitudes – considered socially relevant; 2) a community already established with the aim of coordinating the "Science Club" activities; 3) some experience in stimulating the involvement of families in school activities proposed by teachers; 4) the collaboration between different education levels; 5) some tradition in involving students and teachers in social actions with positive impact in the community.

The schools established robust partnerships with parents and local entities, including the City Hall, and some NGO from the area of environment. These collaborations, together with the Schools' Directive Board, were considered essential for implementing the proposed improvements. The

students developed detailed action plans and cost estimates, which were presented to these partners to secure support and resources. This collaborative approach ensured that the project had a real impact, beyond the classroom, fostering a sense of community engagement and practical action.

So, the CoP was established through a combination of existing partnerships and new collaborations. Stakeholders were identified based on their ability to contribute to the project's goals, with a focus on improving the school's infrastructure and promoting sustainability. The CoP included a wide range of participants, from teachers and students to local government officials and parents.

CoP members, including students and teachers, played an active role in the learning process. The collaborative nature of the project allowed for a rich exchange of ideas and fostered a deeper understanding of the issues at hand. The older students' involvement with the younger students exemplified peer learning and mentorship. This iterative process ensured that the project remained relevant and engaging, providing a dynamic and impactful learning experience for all participants.

Another important fact supporting the CoL development was the fact that the school cluster had one “Science Club”, supported by Ciência Viva (our societal partner), aimed at the development of collaborative projects between students, teachers, scientists, science centres’ members, parents and other community members focused on the inquiry and resolution of local problems that the school community would like to address. This “Science Club” was an important pivot for all the activities and for the combination between COSMOS activities with activities proposed by other projects developed e.g. by the City Hall (local government) and the Nature Protection League (NGO in the area of environment).

The activities within the CoP included interactive workshops – implemented by an Environmental Engineer from the City Hall and some volunteers from the Nature Protection League – where students learned about sustainable practices and explored creative solutions for their school environment. The shared interest in creating a more sustainable and pleasant school environment served as a unifying goal for all involved.

The decision to focus on "the school of the future" as the SSIBL theme was driven by the need to address the specific issues faced by the schools. The co-design process was highly participatory, involving students and teachers in brainstorming sessions and practical activities. The project leveraged both traditional and digital tools, with older students using Minecraft to design digital

models of their ideal school, while younger students created physical models. This dual approach allowed for a rich exploration of ideas and facilitated a deeper understanding of architectural and environmental considerations.

The project engaged students in a comprehensive examination of their school's current state and its potential for improvement in terms of sustainability. The older students (11th grade) conducted interviews with younger students from the different school levels, trying to identify their desires for a future school and assessing current issues such as sustainability, temperature control, the presence of greenery, and water drainage. These interviews revealed a range of concerns and aspirations, forming the basis for subsequent project activities. Then, based on a discussion process of the collected data, both age groups (from primary and secondary schools) proposed their visions for a future school. These visions were shared and discussed between the two groups of students in common sessions. The secondary school students created digital representations using Minecraft and prepared implementation plans focused on concrete proposals – with a study about the materials and costs involved in each one of them. The primary school students constructed physical models of the school, exemplifying the proposals to be presented to external stakeholders.

Students' proposals included practical measures such as installing photovoltaic panels to provide shade and generate electricity, planting more trees, growing plants in the fences around schools and improving water drainage systems. These initiatives were supported by detailed cost plans and action strategies, which were presented to the School's Directive Board and to the City Hall (local government). This active involvement in real-world issues reinforced the importance of civic engagement and demonstrated the impact that young people can have on their community. Some of these proposals were already implemented in the school or in the local community, with the help from the City Hall: several trees were planted in the schools' areas; other plants were placed at the fence that separates the two schools trying to increase the green area and the available shadow; organic composters were distributed by the schools and the houses from the community; vases with plants were placed in the majority of the buildings.

The culmination of this project was the presentation at the Pavilhão do Conhecimento, where all COSMOS partner schools gathered to showcase their work. This event provided a platform for students to present their models and discuss their insights on sustainable buildings.

COSMOS-CoP Impact

The project had a strong impact on students, fostering a sense of responsible citizenship. Students were not only encouraged to think critically about their environment but also to take practical steps towards improvement. They identified specific issues within their school, such as inadequate green spaces, poor temperature control, and water drainage problems. By proposing concrete solutions and collaborating with local authorities, they gained a strong sense of agency and responsibility.

Compared with the first year of COSMOS, the teachers from the School Cluster showed a remarkable capacity to combine/articulate people and resources from different projects offered to the Cluster. The activities were planned by the teachers to integrate in a coherent way the different proposals and requirements from several projects. This allowed a much better involvement (than last year) from external members from those projects and a much better use of resources. This second year, teachers had less difficulties planning and establishing collaborations with external groups/institutions. However, the initial idea developed in Prague, of sharing initiatives between the two school clusters, didn't happen due to time constraints and difficulties to articulate the agendas of both school clusters. Compared to last year (affected by a teachers' strike), the ACT phase was implemented in a much better way, with some impacts at school and community level.

This year, all the COSMOS process began much sooner than last year (affected by teachers' strikes), allowing a much calmer and better planned implementation of COSMOS activities.

One of the most significant lessons was the importance of flexibility and adaptability in project planning and execution. The schools faced different challenges and had to tailor the initial project proposals from Prague to fit their unique circumstances and the specific needs of their students. This adaptability allowed the projects to remain relevant and engaging, particularly by focusing on practical and locally relevant issues like sustainable building practices.

Another lesson confirmed was the value of collaboration between different age groups and disciplines. In one group of schools, older students researched sustainable building practices and shared their knowledge with younger students, fostering a collaborative learning environment. This approach not only enhanced the learning experience but also promoted a deeper understanding of sustainability among students of different ages.

The successful execution of SSIBL-CoP projects heavily relied on the engagement and initiative of the involved teachers. Engaged teachers act as catalysts for the project, generating innovative ideas and motivating students to actively participate. They are essential in maintaining enthusiasm and direction, ensuring that the project's objectives are met. In the context of the schools in Almada, the dedicated teachers played a crucial role in adapting the initial proposals to the local realities, customising the content to meet the specific needs of the students and the school environment.

Moreover, the support of the school management is vital for the sustainability and continuity of these projects. School administration not only facilitates the allocation of resources but also creates an environment that values and prioritises innovative educational initiatives. This support is particularly important to ensure that the projects and their outcomes do not regress after the departure of key teachers or other significant team members.

The implications for the Open School approach include the need for increased community involvement and the integration of real-world issues into the curriculum. The projects demonstrated that when students engage with topics that directly impact their lives and communities, they are more motivated and invested in their learning. The partnerships with local entities, such as the City Hall and NGOs, were crucial in providing resources and support, showing that strong community ties can enhance educational projects. Moreover, the inclusion of external stakeholders, such as environmental groups and local experts, enriched the students' learning experiences and provided practical insights into sustainability issues.

The CoP initiatives implemented were well-received by various participants, who found them both interesting and relevant. Students appreciated the hands-on learning experiences, such as constructing models of sustainable buildings and engaging in discussions about environmental issues. These activities allowed them to connect theoretical knowledge with practical applications, making the learning process more meaningful.

Teachers valued the professional development opportunities provided by the CoP. The collaborative environment fostered by the project encouraged the exchange of teaching strategies and innovative approaches. This shift from traditional lecture-based methods to more inquiry-based and student-centred learning was highlighted by teachers as a significant benefit. They noted that this change not only made lessons more engaging for students but also enriched their own teaching practices.

The practical focus of the projects, such as engaging with local authorities and exploring sustainability at home, resonated with families and community stakeholders. The involvement of local entities in the projects was seen as a valuable aspect, providing students with a broader perspective on real-world issues.

Teacher Professional Development

This year, the "Romeu Correia" school cluster was participating in COSMOS for the second consecutive year. So, they already had a good understanding of the COSMOS approach. This way, the Portuguese COSMOS team didn't repeat the TPD from the previous year (organised around the three conceptual components: learning in/as a community, SSIBL-CoP, Reflection). Instead, we had three moments. The first moment was the Prague meeting. According to the involved teachers, the meeting in Prague proved to be quite effective in broadening their horizons regarding possible SSIs to select, and how to create a CoP around it to conduct SSIBL-CoP and to open the school to the community. In the Prague meeting, they had the opportunity to interact with colleagues from Portugal and other countries. This meeting allowed them to choose a common SSI for both school clusters. The second moment took place after the Prague meeting and was used to discuss with the teachers: a) the SSI selected by the CORPOS and the inquiry activities that could be implemented by students (with the aim of facilitating and supporting the co-design process of SSIBL-CoP units/lessons for different COSMOS' stages); b) ideas about possible members for the CoP (both internal and external to the cluster); and c) possible ways of opening the school to the community (even more than what was achieved during last implementation). The third session happened at the end of the school year to discuss: a) the successes and challenges encountered by the teachers in implementing the SSIBL-CoP process and opening the school to the community (in the different dimensions); b) the lessons learned during round 2 implementation; c) the COSMOS impact in students, teachers, schools and school clusters learning. In all the three moments, teachers were invited to reflect on the learning process of themselves, their students and their schools.

All the CORPOS members (teachers from different schools – primary and secondary; members from the HEI; member from the societal partner) were involved in the professional development around COSMOS. All were quite active in the discussions about the different topics addressed. Primary and secondary school members participated in the same PD initiatives. The PD took place with all the members from a school cluster.

Teachers valued the professional development opportunities provided by the CoP. The collaborative environment fostered by the project encouraged the exchange of teaching strategies and innovative approaches. This shift from traditional lecture-based methods to more inquiry-based and student-centred learning was highlighted by teachers as a significant benefit. They noted that this change not only made lessons more engaging for students but also enriched their own teaching practices.

The practical focus of the projects, such as engaging with local authorities and exploring sustainability at home, resonated with families and community stakeholders. The involvement of local entities in the projects was seen as a valuable aspect, providing students with a broader perspective on real-world issues.

Through the Teacher Professional Development initiatives, the COSMOS project achieved an impactful educational experience for both students and teachers. The initiatives undertaken were effective in bridging theoretical knowledge with practical applications, making learning more engaging and relevant. The shift towards inquiry-based learning and student-centred approaches marked a significant departure from traditional teaching methods, enriching the educational landscape. The project not only fostered professional growth among teachers but also empowered students to take an active role in their education and community. Despite challenges like time constraints and curriculum integration, the project successfully promoted a culture of collaboration, innovation, and sustainability within the participating schools. The collective efforts and the enthusiasm demonstrated by all participants reflect a positive overall balance, highlighting the project's success in fostering a more open and engaged school community.

The TPD faced some obstacles: a) time constraints and a work overload experienced by many teachers; b) only a reduced number of teachers were motivated to participate in the project; c) during each school year, teachers are invited to participate in a large number of projects, causing some limitations in terms of their availability to participate in all of them (they had to choose according to the demands of each project and their personal time constraints). These obstacles were overcome through the reduction of TPD to a minimum time and through the teachers' strong willingness to innovate and experience different methodologies and activities in their classes.

Compared with the first year of COSMOS, the teachers showed a remarkable capacity to combine/articulate people and resources from different projects offered to the School Cluster. The activities were planned by the teachers to integrate in a coherent way the different proposals and

requirements from several projects. This allowed a much better involvement (than last year) from external members from those projects and a much better use of resources. This second year, teachers had less difficulties planning and establishing collaborations with external groups/institutions.

The TPD development was possible due to the previous personal and professional relations between the teachers and the IE-ULisboa team and between the teachers themselves. Without these previous successful experiences between different elements, the TPD would become much more difficult to implement. The CoP was facilitated by the previous experience of collaboration between different school levels and between schools from the same cluster. It is always difficult to find other teachers willing to participate.

The SSIBL-CoP design and implementation was quite facilitated by the last year COSMOS experience and the previous experience/involvement of some teachers in a CoP (created by IE-ULisboa) centred on students' and teachers' activism: the SSIBL-CoP has a lot in common with the initiatives we have been developing.

The CoL and the TPD in each School Cluster was quite effective in promoting collaborations between school levels and with external institutions or groups from other projects.

Compared to last year (affected by a teachers' strike), the ACT phase was implemented in a much better way, with some impacts at school and community level. All the SSIBL stages were accelerated by students' enthusiasm, despite the implementation of most COSMOS' activities at the end of school year, when they have a lot of work and are already tired.

Compared with the first year of COSMOS, the teachers from the School Clusters showed a remarkable capacity to combine/articulate people and resources from different projects offered to the Cluster. The activities were planned by the teachers to integrate in a coherent way the different proposals and requirements from several projects. This allowed a much better involvement (than last year) from external members from those projects and a much better use of resources. This second year, teachers had less difficulties planning and establishing collaborations with external groups/institutions. However, the initial idea developed in Prague, of sharing initiatives between the two school clusters, didn't happen due to time constraints and difficulties to articulate the agendas of both school clusters. One of the most significant lessons was the importance of flexibility and adaptability in project planning and execution. The schools faced different challenges and had to tailor the initial project proposals

from Prague to fit their unique circumstances and the specific needs of their students. This adaptability allowed the projects to remain relevant and engaging, particularly by focusing on practical and locally relevant issues like sustainable building practices.

Another lesson confirmed was the value of collaboration between different age groups and disciplines. In one group of schools, older students researched sustainable building practices and shared their knowledge with younger students, fostering a collaborative learning environment. This approach not only enhanced the learning experience but also promoted a deeper understanding of sustainability among students of different ages.

Overall Balance

The COSMOS project achieved a well-rounded and impactful educational experience for both students and teachers. The initiatives undertaken were effective in bridging theoretical knowledge with practical applications, making learning more engaging and relevant. The shift towards inquiry-based learning and student-centred approaches marked a significant departure from traditional teaching methods, enriching the educational landscape. The project not only fostered professional growth among teachers but also empowered students to take an active role in their education and community. Despite challenges like time constraints and curriculum integration, the project successfully promoted a culture of collaboration, innovation, and sustainability within the participating schools. The collective efforts and the enthusiasm demonstrated by all participants reflect a positive overall balance, highlighting the project's success in fostering a more open and engaged school community.

The emphasis on sustainable building practices provided a concrete context for students to explore their roles as responsible citizens. By engaging in real-world problem-solving, students learned about the importance of environmental stewardship and the impact of their actions on the community. The project's activities, such as collaborating with local authorities and advocating for school improvements, allowed students to experience firsthand the responsibilities and rights of citizenship.

Moreover, the creation of SLEs, where students could learn from each other and from real-world interactions, enhanced their social and emotional learning. These environments facilitated peer learning, critical thinking, and collaborative problem-solving, making the concepts of citizenship and SLEs not just theoretical constructs but lived experiences. This approach not only educated students about their civic duties but also empowered them to contribute positively to their communities.

3.5. The case study from Sweden

Should we ban snuff?

Background of the school involved in the implementation including description of CORPOS

The school involved is a secondary school in the municipality Filipstad in the middle of Sweden. The municipality has less than 10 000 habitants. There are about 300 students at the school and around 50 employees. The students are in the age of 13-15 years. On the school website it is written that:
"Our school is multicultural with students who care about each other. We attach great importance to good relationships between students and adults at the school."
As in most Swedish schools the teachers are organised into teams and at this school, Ferlinskolan they have four teams.

The school has had collaborations since many years with Karlstad University, both as a school that receives student teachers during practice and also in different projects related to science. They also participated in the first round of implementation in the COSMOS project.
The CORPOS consists of two science teachers being the science teacher leaders at the school, well, one of the with a little bit more of leading role during this implementation. The teachers also teach mathematics and technology. In addition, the principal of the school has been involved supporting the teachers in any possible way, also in interest of all kinds of development at the school, most of all a good school climate as stated on the school website. In addition, one staff from Karlstad University was involved in this second round of implementation. The societal partner, Alma Löv museum was not involved in the second round due to several reasons (this will be explained later on).

The CORPOS functions very well because it has actually been developed through many years of collaboration and a mutual interest in the collaboration, both within the school and between the school and the university.

The school context from an Open Schooling perspective

As already mentions, the school is multicultural with many students from different countries. Actually, many of the came to Sweden as immigrants some years ago. Hence, a lot of work was made at the school to integrate the new students in all possible ways. The great number of immigrants was at its peak in 2016, so since then a lot of development has of course occurred. Among the students with a Swedish background, only few come from families with academic backgrounds.

From the perspective of Shared governance, it is stated as in most Swedish school that this is quite outward. Meaning that teachers decide themselves how to teach. The principal is the school leader, but mainly being in charge of things such as scheduling, staff issues, budget issues, taking the main responsibility in case of emergencies etcetera. The teachers have a lot of freedom. However, the teachers need to follow the national curriculum in terms of what students are supposed to learn, hence to make sure that the students can achieve the learning objectives. This is not seen as a barrier by the teachers, but rather as a way to make education equal to all students, no matter which school they are attending. How to teach is not regulated in the curriculum or any documents at the school. As already mentioned, in terms of Inner school communities, the teachers work in teams. This also means that sometimes, not always, they are at least two teachers working together in the classroom. The two science teachers at the school actively participating in the COSMOS project mean that they use a range of teaching strategies. Hence, sometimes students work in small groups and sometimes teaching is inquiry-based etcetera. In other words, the teachers mean that they are quite outward in this aspect (Learning communities) as well. Not as outward as in the dimension of Shared governance and Inner learning communities, but still on the outward side. When it comes to Student participation the teachers mean that this is something can could be developed. The put themselves at the middle of outward and inward during the pre-focus interview. The students have a student council at the school and there are open relations between students and teachers and also to between students and principal. However, the students do not decide on what to learn or how, this is up to the teachers.

Parental involvement is very much inward. There are several reasons for this. One of them being that the teachers do not want a lot of parental involvement, they see themselves as the experts in teaching and most parents do not have this competence. Any extra Social engagement relating to projects out of school has not been on the agenda. They simply have enough challenges to handle to take care of all the students with different backgrounds. Finally, Community collaboration is the dimension they all want to develop. This was something they had more of before the Covid19 pandemic, but since then it has been difficult to have collaborations with different organisations. They used to visit for instance the water treatment plant in the municipality, but they did not receive any visits from students anymore. To go on tours outside the municipality is a challenge, because this costs money and the municipality has bad economy. This is something that even the students are aware of and declare this as an explanation of why they have hardly any tours out of school.

The process of the SSIBL-CoP implementation

In this school CORPOS remained almost the same as during round 1 with two teachers taking a main responsibility and with support from 1 partner from Karlstad University. However, during this second round the societal partner was not involved because of changed conditions at the museum and no exhibition relating to the chosen SSIBL theme that was about snuff. The choice of this theme was made by the teachers because it fitted well with what was included in the curriculum, learning about drugs. In addition, the teachers had noticed that it had become even more popular for young students to use snuff and especially the new white kind attracting more girls. Hence, the choice of SSIBL theme made the work an integrated part of the curriculum, or put in other words, an "add-in" instead of something extra put as an "add-on" in the school activities. The school class involved has some students with study difficulties.

In this school, the CORPOS remained largely unchanged from round 1, with two teachers taking the primary responsibility and receiving support from 1 staff member from Karlstad University. However, as mentioned before, in this second round, the societal partner was not involved due to changes at the museum and the absence of an exhibition related to the chosen SSIBL theme, which was about snuff.

The teachers selected this SSI theme because it aligned well with the curriculum's focus on drugs. Additionally, they observed an increase in the popularity of snuff, particularly the new white variety, among young students, especially girls. This, integrating the SSIBL theme into the curriculum made it an "add-in" rather than an "add-on" to school activities.

The class that was involved in the implementation included some students with learning difficulties, so an additional teacher was involved to especially support this students.

The teachers aimed to give students significant control and minimise reliance on textbooks. The students brainstormed ways to gather information, suggesting online research, consulting the school nurse, contacting various organisations, and asking questions around town. The students worked in small groups to identify organisations that could provide information and become part of their CoP. The found the snuff factory, the 1177 health care website, a drug therapist and a doctor. Each group had to draft at least five questions for the agency they were contacting. The science teacher assisted students in emailing organisations, but responses were scarce, with some simply referring to their websites. Both students and the science teacher were disappointed by the lack of interaction with

these organisations. However, the school nurse also participated in the theme. This led to CORPOS evolving into a at least a small Community of Practice (CoP). The school nurse attended some lessons to answer students' questions and tried to support them in their inquiries.

The SSIBL-CoP implementation included a lot of student participation even though the theme had been decided by the science teacher. The mathematics teacher was on board and supported in the inquires that included how to create questions for inquires to be made with people in the town. This teacher also supported the students when making diagrams of the results and both teachers had discussions with the students about simple statistics. The HEI partner was not involved in designing any of teaching units, but served as a support in the background, encouraging the process as well as the principal. Hence, the science teacher initiated the SSIBL theme and the first step of the ASK phase. The students were involved in creating more specific questions for their inquiries. The FIND OUT phase was mainly led by the science teacher and to some extent the mathematics teacher, but the students were very active during every lesson. The science teacher decided together with the students that the ACT phase would be in the form of each group making and presenting posters at the end of the project.

Altogether about lessons during 1 hours each were spent on the implementation, with about two lessons per week. During the last two weeks the science teacher could not work because of family matters and now the mathematics teacher stepped in and took the responsibility so the work could be finalised before the summer vacation. At the beginning of the new term the HEI partner visited the school and talked to students about their work and watched the posters. The students were still very engaged and explained that this had been a really good project, something they had enjoyed a lot, but because the theme was of their interest, but also because of the way they had worked.

The teachers were also very happy and also a little bit surprised of how engaged their students had been. The class was considered as a "difficult" group, but this time had worked as never before. The science teacher said: *We need to work more like this*!"

The only disappointment was as already mentioned the lack of interest from other organisations to collaborate. This was indeed a negative surprise since at least more health organisations were expected to show an interest in being involved.

The COSMOS-CoP impact

The teachers had decided from the start that they wanted to have more community collaboration and that this was the Open Schooling dimension they were most interested in developing. However, after the first round of implementation they also said that they wanted to develop student participation and this is actually where they were most successful in the second round of implementation as the students were involved already from the beginning, also in trying to find partners to involve in a CoP.

Less successful was the community collaboration because of the lack of interest from organisations. The reason for choosing this case study is because it is quite typical for the cases in Sweden. The schools that have been involved in COSMOS are all situated in small cities, with few organisations and companies. There are countryside places with few "experts". Hence, creating CoPs has turned out to be a big challenge when schools are not located in big cities. Still, collaboration with the HEI partner is established and "experts" can be found at the university within several subjects, including health issues. So, a lesson learned is that we could have used more people from the university in the implementation than we did. Still, it was a good choice of SSIBL theme because it engaged the students. Teachers and students were positive to the COSMOS approach, especially working with SSIBL. Student participation developed with a class that was considered as "difficult", with many students with special needs. Still, the outcome was exceptional positive. Hence, teachers should not be afraid of trying new teaching strategies even with "difficult" classes. Maybe that even is a successful way to overcome the "difficulties".

Flexibility in planning and adapting to unforeseen circumstances (like teacher absence) is vital.

Teacher Professional Development

The TPD started before the first implementation and followed the structure of the TPD handbook. The COSMOS approach was presented, SSIBL and how to work in CoPs. This was done first via an online meeting (the two leading science teachers and principal participated with the HEI partner), then a half day at the school with the science teachers. One hour with joint discussions were also held with in total four science teachers, the principal and the HEI partner, this meeting was conducted at the school, main focus was how to work with CoPs. The TPD was led by the HEI partner. This was then followed by an extra meeting with the societal partner preparing for the first implementation that was held partly at the Alma Löv art museum. One of the science teachers (the one leading this second implementation round) also participated in the TPD held in Prague in November 2023.

Since the science teachers were familiar with SSIBL since before, not so much time was spent on this during the TPDs at the school. Mostly repeating to find out if we were talking about the same thing. During the first implementation there were more of integration between the involved partners in designing the learning units and implementing SSIBl-CoP. In this, the second implementation the science teacher took the lead, but with a lot of student participation deciding together what to do and how. As mentioned before the mathematics teacher also was involved and especially during the last two weeks.

The science teacher who participated in Prague meant that this was very useful and inspiring, to be able to discuss with other teachers from other schools and to become inspired. Hence, the TPD in Prague was considered as especially successful.

Final reflective remarks

The teachers that participated in the COSMOS project did not think that their teachers' professional identity had changed. Rather, that what they believed in since before was confirmed and that they were reminded of how positive the effect is on students when they have more community collaboration and also go out of school.

This school was a good foundation for sustainability in further development of an Open Schooling approach. They work in teacher teams. They have great support from their principal and an established and well-grounded collaboration with Karlstad University. To find other partners is their greatest challenge being situated in a small city with bad economy. Still, the interest in development from teachers and school leader makes development possible, even though steps may seem small.

3.6. The case study from the United Kingdom

CORPOS

Our collaboration with Primary School 2 in the UK during Round 2, was initiated via the existing network between the HEI partners and the school's science coordinator. We had previously collaborated with this school on science education projects focusing on outdoor learning and biodiversity enhancement. The school had a strong relationship with the University of Southampton taking part in their Science and Engineering Day (for which the University provided funding) and other Public and Community engagement projects. The school's ongoing relationship with the University for their science education provision was commented on positively in reports the school had received by

the UK government's education regulator (OFSTED – Office for Standards in Education, Children's Services and Skills). This strong working relationship with the lead teacher and the school leadership's openness to working with the University of Southampton and external stakeholders was a strong facilitator for CORPOS and SSIBL-CoP implementations.

The collaboration was initiated with a recruitment meeting with the school's leadership team (Executive Headteacher and Headteacher), and the science coordinator where the COSMOS aims were shared and a discussion of how we could work together to benefit the school and achieve our aims took place. Once the school leadership gave permission for the science coordinator and teachers to go ahead with our COSMOS collaboration, we organised two TPD sessions with CORPOS members:

- all teachers (two Year 3 teachers, and two Year 4 teachers)
- two HEI partners
- two societal partners (but who were not able to be present at TPD sessions).

Using the updated TPD handbook provided by WP5 as a guide, the first TPD session took place in October 2023, and focused on exploring the concepts of learning as a community (Figure 1) and conducing the school openness assessment through a focus group discussion. We used the ideas in Figure 5 to inform our discussions about the SSIBL-CoP implementations we wanted to develop and to inform our co-designed materials.

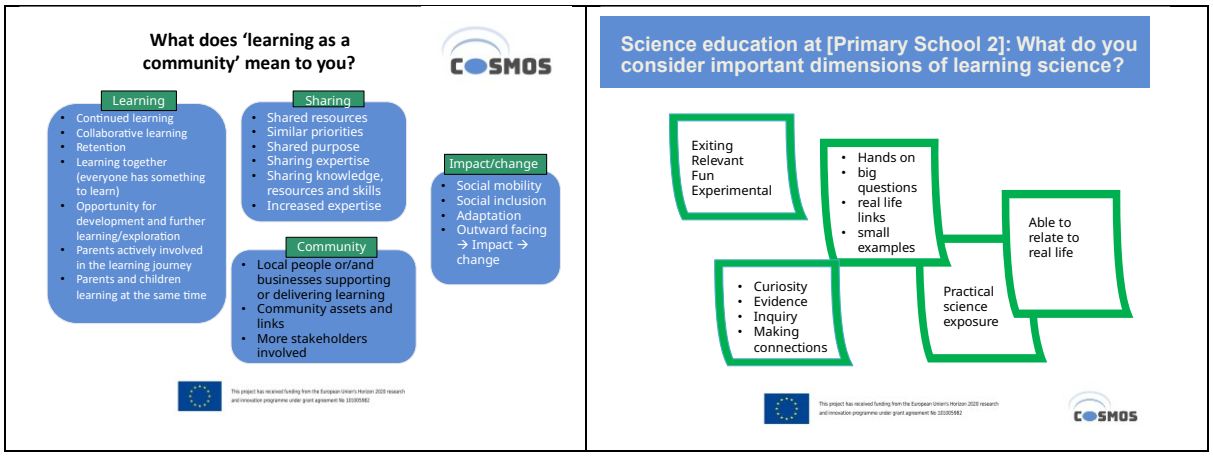


Figure 5: The key aspects considered important for learning as a community and of science education for Primary School 2

Based on the outcomes of discussing school openness dimensions we focused on finding ways of increasing student participation and parental involvement providing opportunities for parents to participate in their children's learning, as shown in the openness visualization below (Figure 6)

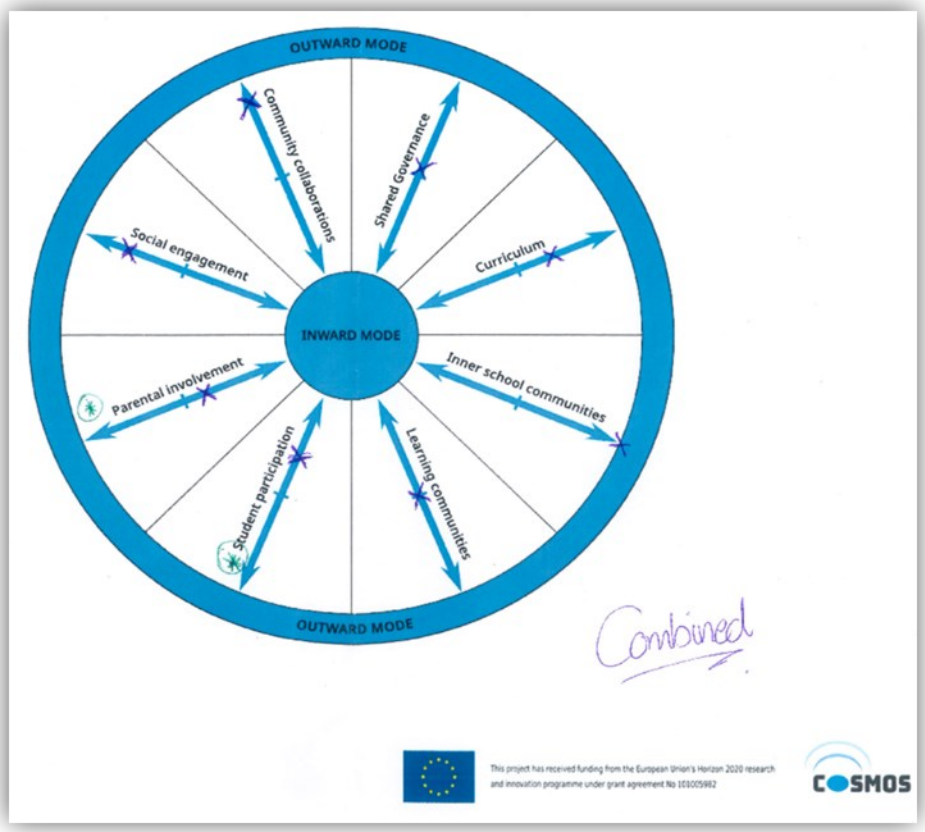


Figure 6: The school openness visualisation for Primary school 2 at the start of the implementation.

The second TPD session took place in December 2023, following the COSMOS Teacher conference in Prague, which the science coordinator of this school (Year 3 teacher) was able to attend and participate. TPD2 focused on SSIBL and led into the co-design sessions, that took place in March 2024, as it was agreed that the implementation would take place during the Spring and Summer terms of the school year. We had two SSIBL-CoP implementations facilitated, supported and implemented in this school, one for Year 3 and one for Year 4 as described next. We had separate co-design sessions with each year group to co-create the lesson sequence and materials needed for each SSIBL-CoP implementation.

To address parental involvement in our SSIBL-CoP designs, we organised three sessions for each year group spread across the unit where parents could come into school and work with the children on

relevant activities with the support of CoP members. The sessions overlapped with the end of the school day to make it convenient for parents to attend.

SSIBL-CoP implementation with Year 3: How can we make our school community healthier?

The Year 3 teachers have worked with two HEI partners on adapting their science curriculum to make it more open to their community focusing on their Healthy Bodies unit. The three sessions were parents could be involved were during Lesson 4, 7 and 11 of the SSIBL-CoP implementation, as described in Table 3.

Table 3: SSIBL – CoP implementation with Year 3 in a new primary school in the UK

SSIBL dimension	Description	Duration
ASK	Key SSI question: How can we make our school community healthier? Lesson 1: The teacher introduced the SSI question to the pupils	1 hour approx.
FIND OUT	Lesson 2: Students investigated 'What do our bones do' learning about the human skeleton and then thinking about how to keep their bones healthy, linking the lesson to the key SSI question. Lesson 3: Pupils continued their investigations on the human skeleton by designing tests to investigate questions such as 'Can you jump further if your femur is longer?' Lesson 4, with parents (1.5h): Children reviewed subject knowledge with their parents, before working with HEI partners in exploring what it means to be healthy, and coming up with questions for a school-wide questionnaire in order to start working on their SSI question (FIND OUT) Lesson 5: Muscles and Bones – building a model of a human hand Lesson 6: Learning about teeth and how to keep them healthy; make a pledge on how to keep teeth clean (ACT) Lesson 7, with parents (1.5h): the Saints Foundation collaborated with parents and the teachers and run activities for parents and children to discover together how exercise and sports supports a healthy lifestyle Lesson 8: children continued investigations into how to keep teeth healthy	16 hours approx.

	Lesson 9: Children conducted investigations using egg shells to find out how different drinks affect enamel Lesson 10: Children focused on learning about nutrition and how different nutrients support a healthy body Lesson 11, with parents (1.5h): Southampton Catering Services, who provide the school's meals worked with parents and children to design healthy food plates, made their own pizzas, and learned about different fruit getting the chance to taste new fruit to them Lesson 12: Children visited Winchester Science Centre, our societal COSMOS partner, where they learned more about how the heart works and explored the Centre's exhibits (whole day) Lesson 13/School assembly: During a school assembly at the start of the day, a member of the company supplying food to the school, talked to all KS2 children (Years 3-6) about healthy eating habits, and the Year 3 children were credited for their work on this area for the whole school.	
ACT	Lesson 14: Children designed posters including facts about healthy eating and exercise to put them around school spaces to inform other pupils and staff at the school about how to be healthier. Lesson 15: Four posters based on the children's designs were printed out and places in various places around the school (e.g. the posters about washing hands was placed in the children's toilets, and posters about exercise were places in the outdoor school grounds.	2 hours approx.

Overall, during this SSIBL-CoP implementation, CoP members were involved in the FIND OUT stage but the ASK stage was co-designed with the CORPOS team based on the school's needs and children's interests, but without the involvement of CoP members. Importantly, the community level of the ACT stage in this SSIBL-CoP implementation was the school, so the children's posters were aimed at this community group.

SSIBL-CoP implementation with Year 4: How can we enhance our school's biodiversity?

The Year 4 teachers worked with the HEI and societal partners on adapting their science curriculum to make it more open to their community focusing on their Living things unit (biodiversity loss was the

SSI chosen). The three sessions where parents could be involved were during Lesson 4, 6 and 8 of the SSIBL-CoP implementation, as described in Table 4.

Table 4.: SSIBL – CoP implementation with Year 3 in a new primary school in the UK

SSIBL dimension	Description	Duration
ASK	Key SSI question: Why does biodiversity affect our local area and how can we support it? Lesson 1: The teacher introduced the SSI question to the pupils, introduced the concept of biodiversity and linked to the need to take action to protect our environment.	1 hour approx.
FIND OUT	Lesson 2: Students learned about classification of animals and living things, through observation and compare and contrast activities Lesson 3: Students observe their school grounds and record different types of wildlife/living things with the support of WSC partners and teachers. Lesson 4 (same day as L3), with parents (1.5h): Children and their parents work with WSC partners, exploring sounds of biodiversity and their school grounds, building on Lesson 3. Children and parents come up with an action plan of what they would like to have more on their school grounds. Lesson 5: Children learned about the pollination process through modelling and discussion activities. They also investigated the role of plants within food chains. Lesson 7: Students learned about classification of invertebrates and mammals using classification keys and observations Lesson 8, with parents (1.5h): Children and parents work with our COSMOS partners and an engagement officer from the Hampshire and Isle of Wight Wildlife Trust to learn about hedgehogs and make footprint tunnels to find out if they have hedgehogs on their school grounds. Lesson 9: Children visited Winchester Science Centre, our societal COSMOS partner, where they learned more about biodiversity and how to support it (whole day)	12 hours approx.

ACT	Lesson 4 (same day as L3), with parents (1.5h): Children and their parents work with WSC partners, exploring sounds of biodiversity and their school grounds, building on Lesson 3. Children and parents come up with an action plan of what they would like to have more on their school grounds. Lesson 6 (same day as L5) with parents (1.5h): Children, with their parents, teachers and HEI partners planted pollinator friendly plants around their school grounds. Lesson 10: Children wrote and sent letters to the newly elected Southampton City Council to let them know about the work they have been doing in their school grounds and to make suggestions of action about how the Council can support them and other schools in enhancing their school grounds. This action was initiated/suggested by children. Lesson 11: WSC partners visited the school and using their mobile dome supported children with activities learning about our planet and how to protect it.	4 hours approx.

During this SSIBL-CoP implementation, CoP members were involved at various degrees in each of the SSIBL stages.

The ASK stage was co-designed by CORPOS taking children's interests into account, but did not directly involved external CoP members. The issue and key SSI question was identified and formulated by CORPOS.

In the FIND OUT stage, CoP members included the parents as active participants, who attended the sessions organised by the CORPOS for parent-children collaborative learning. Other CoP members such as the engagement officer from the regional Wildlife Trust was a more peripheral participant, with the potential of developing a closer relationship and thus become a more active CoP member in future implementations.

The ACT stage of SSIBL involved CoP members in the form of the city's Council, although these were external stakeholders, as transactional participants (WP2 framework) that were not involved in the design of activities. There was ownership of the ACT stage as children suggested writing and sending letters to the city council (there was an election the previous week and children were aware of this; thus their actions were also relevant and contextualised to their local environment).

Reflections on CORPOS, CoP & SSIBL-CoP implementation with Primary School 2

The CORPOS within this school was facilitated and supported by the lead teacher in this school, which was the science coordinator as mentioned in the previous section. This teacher had experience of working with the University on various initiatives and had previous working experience in science communication and engagement. These teacher attributes facilitated engagement as there was interest from the teachers and a willingness to collaborate. The CORPOS team consisted of the HEI and societal partners, and the Year 3 and Year 4 teachers, who worked collaboratively in developing and delivering the SSIBL-CoP implementation activities. A success of this CORPOS development was the fact that three of the four teachers taking part, did not have previous collaboration opportunities with the HEI and societal partners, but through the COSMOS project were able to develop working relationships and connections with our institutions and our CoP members, and as such experience for themselves how they can network and collaborate with external stakeholders in order to open up their school curriculum.

We were able to follow all the steps indicated in the COSMOS framework (WP2) for formulating CORPOS, although without the presence of leadership in the CORPOS team. Meetings with the leadership team took place at the recruitment stage, but from that point onwards leadership was not involved actively in the planning and implementation of SSIBL-CoP activities, although they were fully supportive of the project and work undertaken.

A key success of the SSIBL-CoP implementation with both year groups was the positive manner in which the activities designed and delivered were received by parents, who were the target dimension in our school openness discussions (parental involvement). The design of COSMOS activities worked well in Primary School 3 for parental involvement and for children's understanding the purpose of the activities in context. One teacher said:

> *"it teed the children up where they had a level of knowledge about what we were actually, like the scientific knowledge was linked to the fun bit we were doing and actually, it wasn't just we're gardening, there was a scientific reason why we were gardening and they could tell us. And they were able to, they could make those links between the two different things we were doing and they were able to sort of explain to their parents why the plants were important rather than just looking pretty" (Year 4 Teacher participant, post focus group School 3, R2P).*

Both SSIBL-CoP implementations were co-designed to support parental involvement. Both implementations and all sessions designed for children-parent collaborative learning were well attended by parents (approximately 20 in each session for Year 3 and 10 in each session for Year 4). Teachers noted that some of the parents attending were parents that would not normally engage with the school. One of the parents that attended all Year 3 sessions, noted in an interview that she was able to attend because the way the sessions were planned allowed her to plan ahead alternative arrangements with her employer, which was not the case for other one-off parental engagement events the school organised. Feedback collected by parents at the end of each session using sticky notes indicated how much the parents valued the opportunity to learn together with their children, and to experience learning with them as part of school activities.

The CoP was formulated based on existing collaborations with the lead teacher and the school, rather than fully depending on external stakeholders, and the HEI/societal partners' networking and support in identifying CoP members. This meant that the teachers were more actively involved in the creation of the CoP, since there was already some common ground and a shared repertoire that CoP members could draw on, although this was more evident with the Year 3 SSIBL-CoP implementation, compared to the Year 4 implementation. For example, one of the CoP members for the Year 3 SSIBL-CoP implementation were the school's catering service staff, who already knew the children and staff. For Year 4, external factors like weather conditions and lack of time, meant that there were less external CoP members involved, although the collaboration of those CoP members involved with the school was successful. For example, the parent-children collaborative learning session where we were planting pollinator-friendly plants (Lesson 6, Table 2.3) took place on one of the hottest days of the school year, which limited the amount of time children and their parents could be outdoors.

The key challenge in the SSIBL-CoP implementations at this new school was how to integrate the Action dimension of the SSIBL framework into the existing science curricula. As the lead teacher noted in the post-focus group discussion "taking action and causing an impact is sadly what historically, traditionally, regularly we don't do". This was however mitigated by the school's existing science curriculum and approach to science education, which was identified as a facilitator, as according to the teachers, they use aspects of the SSIBL framework, and they already have some community collaborations.

> *"these two units of science, I would say, across the whole school this year have had the biggest impact on anything, because they've had an impact. It's really interesting thinking*

about education starting because I think we've almost thought about it the other way round to you because I think we've thought about impact almost first because we had the ASK, and the FIND OUT, it was planned and sorted. So, we've looked at the action stage because that's the bit that's new and different to us, whereas the teaching is the finding out. Well, that's done and that's planned, that's what we do. The asking questions is a big part of working scientifically, a part of the national curriculum anyway, so, the new bit for us was the action and the impact and I think, I can't speak for these guys, but for me, that's the most exciting and gets the most buy in from me because ultimately, that's why teachers teach"

This challenge of not typically addressing ACTION as part of the school science curriculum was also mitigated through the co-design process, as with our support we were able to suggest ideas for actions and to support with networking and identifying stakeholders that could be involved in the Action dimension.

COSMOS Impact

Figure 7 presents the teachers' visualization of the school's openness at the end of the school year. For both openness dimensions on which the teachers decided to focus for the SSIBL-CoP implementation, the teachers indicated some outward movement as a result of the COSMOS project. For student participation, they thought that at the school level, these was no movement, but at the project implementation level with Year 3 and Year 4 classes, they identified an outwards movement.

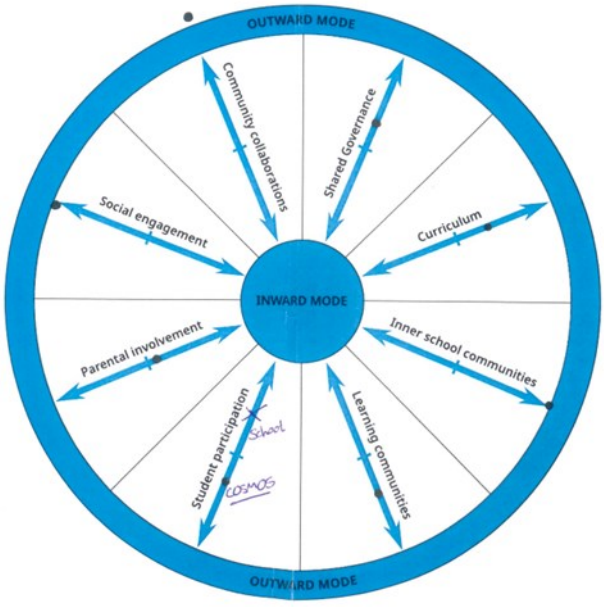


Figure 7: The school openness visualisation for Primary school 2 at the end of the implementation

For parental involvement, the teachers thought that they had a good level of involvement in terms of participation numbers from teachers that attended the afterschool children-parent learning activities, however they differentiate "presence" with "engagement" and note that overall, at the school level, even when parents attend school events they are not "engaged" or "actively listening".

> *"But not very present, say letting the parents act as experts, parents partaking in events, [reads definition of parental involvement] parents considering questions and like parents being an active part of the learning. I suppose to parents, like I think we have a good parental engagement in terms of, or good parental presence participation, but not necessarily engagement. So, I know the music lead was talking about the concert and was saying, "Right guys, can we just stop talking?" thinking she was talking to the children and then turned around and was like, "Oh no". (Laughter) It's not the children that are talking" (Year 4 teacher, post focus group, School 3)*

As a result, parental involvement for this school remained at the same level overall, attributing the challenge of engaging meaningfully the parents to the parents own negative experiences of schooling, and the extent to which they value education and schooling.

On the school level, and as indicated in the quote further above, it is clear that taking part in COSMOS has allowed teachers to identify a key aspect of their science education that is missing, ACT, and to consider how this can become part of their science curriculum. Another impact at the school level, which also indicates the sustainability of the COSMOS approach, is in relation to the learning communities' dimension of the school openness model, a dimension that was not a focal point of the SSIBL-CoP implementation. However, it was that that "in terms of impact, that's the biggest difference that COSMOS has had [on learning communities" and proceeded to discuss how the same approach could be implemented in units on other subject areas such as Spanish.

Impact on teachers was noted in terms of confidence in trying out something different and being braver to pursue collaborations with external stakeholders and the community, as there is mutual benefit from this collaboration.

> *"I think it's been great for me as a new teacher. To know that there's that flex, like T3's alluded to, you know, that flex to do something different. And you know, it's allowed me*

to build my confidence and maybe go I don't need to do it exactly that way. I could do it in a different way. So, I think that it was quite, you know, interesting for me from that point of view" (Year 3 teacher, post focus group, School 3)

"I think knowing that we can be a bit brave" and trying out new things, also understanding how to approach community collaborations, e.g., stakeholders have also to gain from this collaboration, and so teachers should not hesitate to reach out" (Year 4 teacher, post focus group, School 3)

Impact on pupils, that indicate that student participation levels were higher for the COSMOS activities, include the children having a "wow moment" when they realise that they are looking for and improving their school's wildlife. Impact was reported in terms of children realising how their actions are making a difference to wildlife and how they can encourage their parents to do more, as the Year 4 teacher said:

"it's that it's having that proper physical outcome to something that we've done which we don't necessarily always have or we don't always follow through with it 100% because of other restrictions in place, but like the fact that we can, we have actually planted a load of pollinating flowers on the front.[...] And they can see them and they're still alive and we have actually made the hedgehog tunnels which are still outside and they're all there.[...] The fact that they've gone away actually wanting to get involved and react and the parents seemed quite keen and the children seemed quite motivated to encourage their parents to do more as well."

The high levels of engagement that the children demonstrated during the children-parent learning activities were also commented on by the Year 3 teacher showing constancy across the two year groups, for example:

"when you consider when they were looking at what a healthy plate of food would look like or the different food groups or when they were looking at the human body and muscles, skeleton and function and things like that, it complemented it really well because then it brought it to life in my opinion. I think that was the bit that the children really seemed to buzz about, and the fact that they were able to last through till 4.00pm after a whole day at school, they would have needed to have been engaged to do that".

3.7. Global Analysis of Round 2 Case Studies

The COSMOS project offers a transformative approach to education by integrating socio-scientific inquiry-based learning (SSIBL) with real-world issues, fostering interdisciplinary collaboration, and deepening community engagement. However, despite its significant potential, the approach also presents a range of challenges that require thoughtful strategies to overcome. This global evaluation combines the key potentialities, challenges, and solutions for implementing the COSMOS project successfully based on the content of the six case studies.

Potentialities of the COSMOS Approach

1. Fostering Active Student Engagement and Empowerment

The COSMOS approach engages students deeply by connecting classroom learning with relevant socio-scientific issues (SSIs), making education more meaningful and motivating. For instance, in The Netherlands, students investigated urban pigeon management, conducting their own research and proposing solutions to local authorities. In Sweden, students explored the societal impact of snuff usage, linking the subject to their daily social environment. These real-world connections foster a sense of ownership and responsibility in students, enhancing their motivation and engagement.

2. Enhancing Community Collaboration

A key strength of the COSMOS approach is its ability to strengthen ties between schools, communities, and external stakeholders through the formation of CORPOS (Core Organisational Structures for Promoting Open Schooling). In Israel, a project addressing the environmental impact of a new roadway successfully engaged parents, activists, and local officials, leading to a powerful collaboration. Similarly, in Belgium, students worked with societal partners on projects aimed at reducing ecological footprints. These collaborations enrich the educational experience and allow students to connect their learning to real-world societal issues.

3. Addressing Real-World Societal Challenges

The COSMOS approach emphasises the importance of linking education with real-world societal issues, helping students understand the relevance of their learning to larger social and environmental contexts. In Israel, students explored the impact of urban development on wildlife, leading to community awareness campaigns and activism. In Portugal, students tackled the issue of sustainable buildings, engaging in projects that connected sustainability concepts with their local context. These

examples highlight the power of COSMOS to engage students not only academically but also as active participants in societal change.

4. Promoting Interdisciplinary and Inquiry-Based Learning

COSMOS emphasises interdisciplinary learning by integrating different fields of study to solve complex problems. In The Netherlands, for instance, students combined knowledge from biology, social science, and communication to research urban pigeon populations. In the UK, students focused on enhancing school biodiversity, working with local community partners to apply their knowledge of environmental science. This interdisciplinary focus prepares students to tackle real-world challenges that require knowledge from multiple disciplines.

5. Supporting Teacher Development and Collaboration

Teacher professional development (TPD) is crucial to the success of the COSMOS approach. Through TPD sessions, teachers are trained to implement SSIBL effectively. In the UK, TPD workshops helped teachers adapt their science curricula to focus on community-relevant topics. Similarly, in Israel, teachers received support in co-designing learning activities that integrated scientific inquiry with social issues. By providing teachers with ongoing support, the COSMOS model ensures that they are equipped to facilitate meaningful and sustainable educational projects.

6. Empowering Students as Active Citizens, Encouraging Civic Engagement and Action Competence

A key outcome of the COSMOS approach is the empowerment of students as active citizens. Many projects led students to take tangible actions to address societal issues. In Israel, students not only learned about the environmental impact of urban development but also took direct action, organising petitions and public demonstrations against the construction of a new roadway that threatened local wildlife, demonstrating the project's capacity to foster civic engagement. In The Netherlands, students provided advice to local authorities based on their research. In Sweden, students worked with health professionals to raise awareness about the health risks associated with snuff usage. By moving beyond the classroom and into real-world action, COSMOS encourages students to see themselves as capable of making meaningful contributions to society. These projects show that COSMOS enables students to become informed, responsible citizens who can influence their communities.

7. Raising Awareness of Socio-Scientific Issues

COSMOS helps raise awareness of socio-scientific issues both within the classroom and in the wider community. In Israel, a focus on environmental preservation versus urban development led to

increased community participation and awareness. In Sweden, students' research on snuff usage educated their peers and the community about the health risks associated with the practice. These projects demonstrate how COSMOS can bring important social and environmental issues to the forefront of both educational and community discourse.

Challenges of the COSMOS Approach

While the COSMOS project offers considerable potential, several challenges must be addressed to ensure its successful implementation.

1. Time Constraints and Teacher Workload

One of the most significant challenges is the additional time and workload demands placed on teachers. In Portugal, teachers struggled to find time to plan and implement COSMOS projects due to the rigid curriculum and their existing responsibilities. Similarly, in The Netherlands, teachers faced challenges balancing their teaching duties with the demands of inquiry-based learning. Without careful planning and support, the time commitment required by COSMOS projects can lead to teacher burnout.

2. Sustaining Collaborative Networks (CORPOS)

Maintaining the long-term sustainability of CORPOS networks can be challenging. In Sweden, external societal partners were unable to participate in the second round of COSMOS implementation, limiting the scope of community involvement. Similarly, in Israel, sustaining active collaboration with community stakeholders required significant time and effort. Without consistent engagement and institutionalised partnerships, CORPOS collaborations risk losing momentum.

3. Engaging Community and External Stakeholders

Securing active participation from community members and external organisations is another challenge. In Sweden, the teachers found it difficult to engage external experts and organisations, which limited the impact of the project. In Israel, while some parents and local stakeholders were involved, other potential partners were harder to engage. Successful engagement requires selecting SSIs that resonate with the local community and finding creative ways to involve stakeholders.

4. Institutional Resistance and Rigid Curriculum Structures

The COSMOS approach promotes flexibility and inquiry-based learning, which often clashes with rigid curricula focused on standardised testing. In Portugal, teachers found it difficult to integrate COSMOS

activities within the constraints of a structured curriculum. In Belgium, the lack of teacher experience with inquiry-based learning made it challenging to implement SSIBL effectively. Similarly, in the UK, teachers struggled to incorporate the ACTphase of SSIBL into their existing science curricula. Addressing this challenge requires finding ways to align COSMOS activities with curriculum goals and gaining the support of school leadership.

5. Pedagogical Shifts and Teacher Preparedness

Shifting from traditional teaching methods to the inquiry-based SSIBL framework can be challenging for teachers. In Sweden, teachers experienced difficulties in consistently applying inquiry-based learning with diverse student groups. The pedagogical adjustments required by COSMOS projects can be daunting for teachers who are accustomed to more traditional teaching models. Adequate support through professional development and peer collaboration is essential for overcoming this barrier.

6. External Disruptions

Several case studies reported external disruptions, such as strikes, political instability, and logistical challenges, which impeded the continuity of COSMOS projects. In Portugal, teacher strikes delayed the implementation of SSIBL activities. In Israel, ongoing conflict affected the ability of teachers and students to remain focused on the project. These external factors can significantly disrupt the progress of long-term educational initiatives.

7. Resource and Financial Limitations

Organising community activities and engaging external experts require resources that are often limited. In Israel, financial constraints affected the ability to organise field trips and community engagement activities. Similarly, schools in rural areas faced difficulties accessing external expertise due to geographical and financial limitations.

Solutions to Overcome COSMOS Challenges

1. Reducing Teacher Workload and Time Constraints

To alleviate teacher workload, COSMOS activities should be embedded into the existing curriculum, as demonstrated in The Netherlands, where project activities were integrated into science lessons. In Portugal, planning COSMOS projects earlier in the academic year helped distribute the workload more evenly.

2. Integrating COSMOS into the Standard Curriculum to Overcome Institutional Resistance

To reduce the additional burden on teachers, COSMOS activities should be embedded into the standard curriculum. In The Netherlands, integrating the pigeon project into the science curriculum allowed teachers to manage the workload more effectively. In Portugal, teachers worked to integrate COSMOS activities into the structured curriculum, ensuring that they complemented national educational requirements. Teacher professional development (TPD) sessions in the UK also helped teachers adapt their curricula to include COSMOS initiatives. Aligning COSMOS projects with curriculum objectives ensures that they contribute to academic goals without becoming an extra task.

3. Institutionalising CORPOS Collaborations

Formalising partnerships with external organisations through long-term agreements can help sustain CORPOS networks. In Israel, strong relationships with community members and environmental activists helped maintain collaboration over multiple years. In Sweden, formal agreements with societal partners, including HEIs, ensured that collaborations remained active. Institutionalising these partnerships ensures that they remain active even when individual staff members change.

4. Enhancing Community Engagement

Selecting SSIs that resonate with the local community is key to increasing stakeholder engagement. In Israel, choosing the issue of a new roadway threatening local wildlife sparked significant community interest. Schools should also organise community events, such as open days or knowledge-sharing sessions, to foster greater participation from external stakeholders.

5. Providing Ongoing Teacher Professional Development

Regular TPD sessions are essential to help teachers adapt to the SSIBL framework. In the UK, TPD workshops supported teachers in adopting new inquiry-based strategies. In Belgium, collaborative TPD sessions allowed teachers to develop confidence in inquiry-based teaching. Sweden's approach to teacher reflection and adaptation further supported pedagogical shifts. Schools should also establish mentoring systems where experienced teachers can guide their colleagues in implementing COSMOS projects.

6. Flexible Project Timelines

Building flexibility into project timelines allows schools to adapt to external disruptions. In Portugal, the COSMOS team managed to reschedule activities and focus on shorter tasks when faced with teacher strikes. Flexibility ensures that projects can continue even when unexpected challenges arise.

7. Securing Financial Support

Financial and logistical support from external organisations can alleviate the resource constraints that many schools face. Schools can seek grants and partnerships with local businesses or governmental bodies, as seen in the UK, where external funding provided essential resources for COSMOS projects.

Conclusion: A Balanced Evaluation and Path Forward

The COSMOS approach demonstrates significant potential to enhance education by promoting socio-scientific inquiry-based learning, community engagement, and interdisciplinary collaboration. While challenges such as time constraints, teacher workload, and institutional resistance remain, effective strategies—including embedding COSMOS activities into the curriculum, sustaining partnerships, and providing ongoing teacher support—can address these obstacles. With these solutions, the COSMOS model has the potential to revolutionise how students, teachers, and communities collaborate to address real-world socio-scientific issues, preparing the next generation of active, responsible citizens.

4. Final Considerations

The COSMOS project provides a transformative educational model by integrating socio-scientific inquiry-based learning (SSIBL) with real-world socio-scientific issues (SSIs), fostering interdisciplinary collaboration, and deepening community engagement. Although the approach shows significant potential, it also presents various challenges. This global evaluation highlights both the potentialities and challenges of the COSMOS project while offering solutions for successful implementation, based on an analysis of six case studies.

One of the key strengths of the COSMOS approach is its ability to deeply engage students by connecting their learning with relevant socio-scientific issues. By linking education to real-world problems, students gain a sense of ownership and responsibility in their learning. For example, in The Netherlands, students explored urban pigeon management, conducting their own research and presenting their findings to local authorities. Similarly, in Sweden, students studied the societal impact of snuff usage, which resonated with their social environment. These projects showed how real-world connections enhance students' motivation and involvement.

Community collaboration is another strength of the COSMOS approach. Through CORPOS (Core Organisational Structures for Promoting Open Schooling), schools form partnerships with external stakeholders, enriching students' educational experiences by connecting their academic work with societal needs. In Israel, a project on the environmental impact of a new roadway engaged parents, local officials, and activists. In Belgium, students worked with community partners on projects aimed at reducing ecological footprints. These collaborations demonstrate how COSMOS enhances the relevance and impact of student learning by linking it to real-world societal challenges.

The COSMOS approach also emphasises interdisciplinary learning, preparing students to tackle complex issues by integrating knowledge from multiple fields of study. In The Netherlands, for instance, students combined biology, social science, and communication skills to study urban pigeons. In the UK, students applied their understanding of environmental science to a biodiversity project, working with local community partners. This interdisciplinary approach equips students with a broader perspective and the skills needed to address real-world challenges that span multiple disciplines.

Another benefit of the COSMOS approach is its capacity to empower students as active citizens. The model encourages students to take direct action on the societal issues they explore in the classroom.

In Israel, students not only learned about the impact of urban development on local wildlife but also organised petitions and demonstrations to oppose a new roadway. In Sweden, students raised awareness about the health risks of snuff usage, working alongside health professionals to spread their message. These projects show how COSMOS fosters civic engagement and action competence, helping students develop the skills needed to influence their communities positively.

Teacher professional development (TPD) is also central to the success of the COSMOS approach. By providing teachers with the necessary tools and support, COSMOS ensures that educators are well-prepared to facilitate SSIBL projects. In the UK, TPD workshops helped teachers adapt their science curricula to include community-relevant topics. In Israel, teachers received support in co-designing learning activities that integrated scientific inquiry with social issues. This emphasis on TPD ensures that teachers are equipped to lead meaningful, inquiry-based projects in their classrooms.

The COSMOS approach also helps raise awareness of socio-scientific issues within both the classroom and the wider community. In Israel, a focus on environmental preservation versus urban development sparked increased community participation. In Sweden, students' research on the health risks of snuff educated their peers and the community. By bringing important social and environmental issues into focus, COSMOS enriches the educational experience for students while contributing to broader societal conversations.

Despite its many strengths, the COSMOS project faces several challenges. One major difficulty is the additional time and workload required of teachers. In Portugal, for instance, teachers struggled to find time to plan and implement COSMOS projects due to their existing responsibilities and rigid curriculum structures. Similar challenges were reported in The Netherlands, where teachers found it difficult to balance COSMOS activities with their regular teaching duties.

Another challenge is maintaining long-term collaborative networks with external stakeholders, a key component of the COSMOS approach. In Sweden, external societal partners were unable to participate fully in the second round of COSMOS implementation, which limited the scope of community involvement. Similarly, in Israel, sustaining active engagement from community stakeholders required significant time and effort, creating additional challenges for teachers and students.

Engaging community members and external stakeholders consistently is also a challenge. In Sweden, for example, teachers had difficulty securing the participation of local health organisations, which limited the overall impact of the project. In Israel, while initial community engagement was strong, maintaining long-term involvement required considerable effort.

The COSMOS approach also faces institutional resistance, particularly in educational systems that prioritise standardised testing and rigid curricula. In Portugal, teachers found it difficult to incorporate COSMOS activities within the constraints of a structured national curriculum. In Belgium, the lack of experience with inquiry-based learning among teachers made it challenging to implement SSIBL effectively.

Shifting from traditional teaching methods to the inquiry-based SSIBL framework can also be daunting for many teachers. In Sweden, for example, teachers struggled to apply inquiry-based learning consistently across diverse student groups. These pedagogical adjustments require ongoing professional development and support to ensure success.

Finally, resource and financial limitations present another challenge for COSMOS projects. Organising field trips, securing external expertise, and engaging the community all require resources that are often limited. In Israel, for instance, financial constraints hindered the ability to organise field trips and community engagement activities. Similarly, schools in rural areas faced difficulties accessing external expertise due to financial and geographical barriers.

To address these challenges, several solutions have been identified. One effective way to reduce teacher workload is to integrate COSMOS activities into the existing curriculum. In The Netherlands, for example, embedding COSMOS projects into science lessons helped alleviate the burden on teachers. In Portugal, starting COSMOS projects earlier in the academic year helped distribute the workload more evenly.

Sustaining collaborative networks can be achieved by formalising partnerships with external organisations through long-term agreements. In Israel, strong relationships with community members and environmental activists helped maintain collaboration over multiple years. Similarly, in Sweden, formal agreements with societal partners, including higher education institutions, helped ensure that collaborations remained active.

Enhancing community engagement requires selecting socio-scientific issues that resonate with the local community. In Israel, focusing on a local environmental issue—such as a new roadway threatening wildlife—generated significant community interest. Schools can also organise community events, such as open days or exhibitions, to foster greater participation from external stakeholders.
Providing ongoing teacher professional development is critical for the success of COSMOS. Regular TPD sessions help teachers adapt to the SSIBL framework. In Belgium, for instance, collaborative TPD sessions helped teachers develop confidence in using inquiry-based teaching. Schools should also establish mentoring systems where experienced teachers can guide their colleagues through the implementation of COSMOS projects.

Flexible project timelines are another important solution. In Portugal, flexible timelines allowed COSMOS activities to continue despite disruptions such as teacher strikes. Building flexibility into project planning ensures that projects can continue even when unexpected challenges arise.

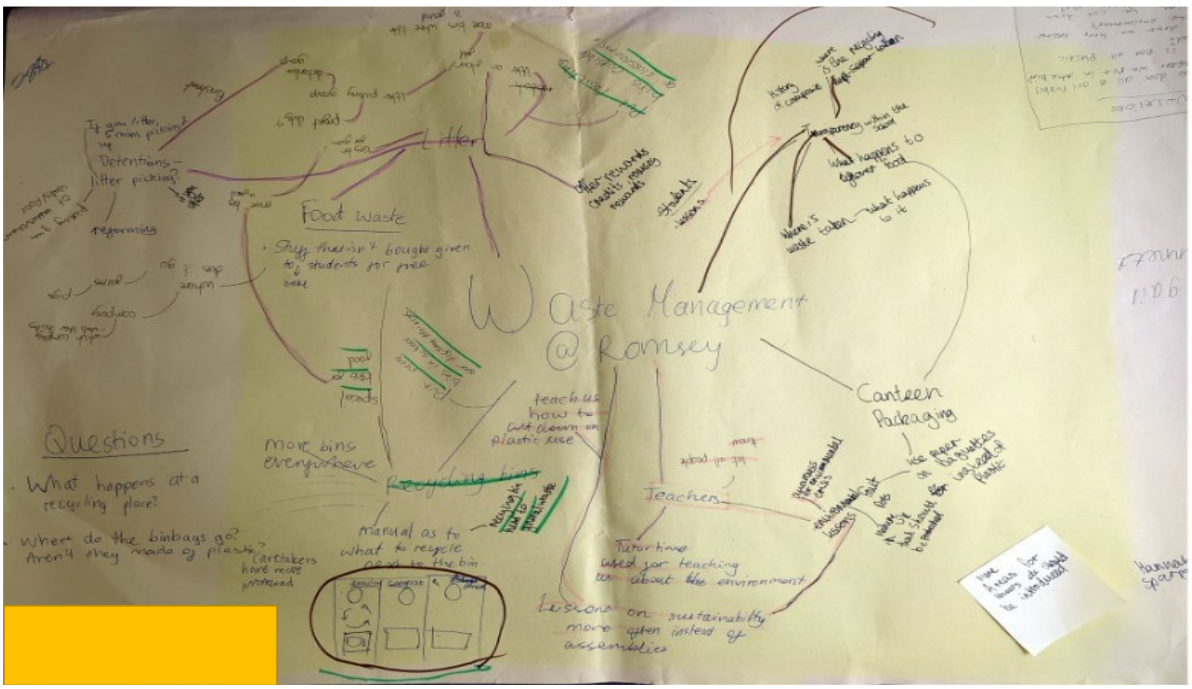
Finally, securing financial and logistical support from external organisations can help overcome resource limitations. Schools can seek grants and partnerships with local businesses or governmental bodies to secure the funding needed to support COSMOS projects. In the UK, external funding provided essential resources that made COSMOS projects possible.

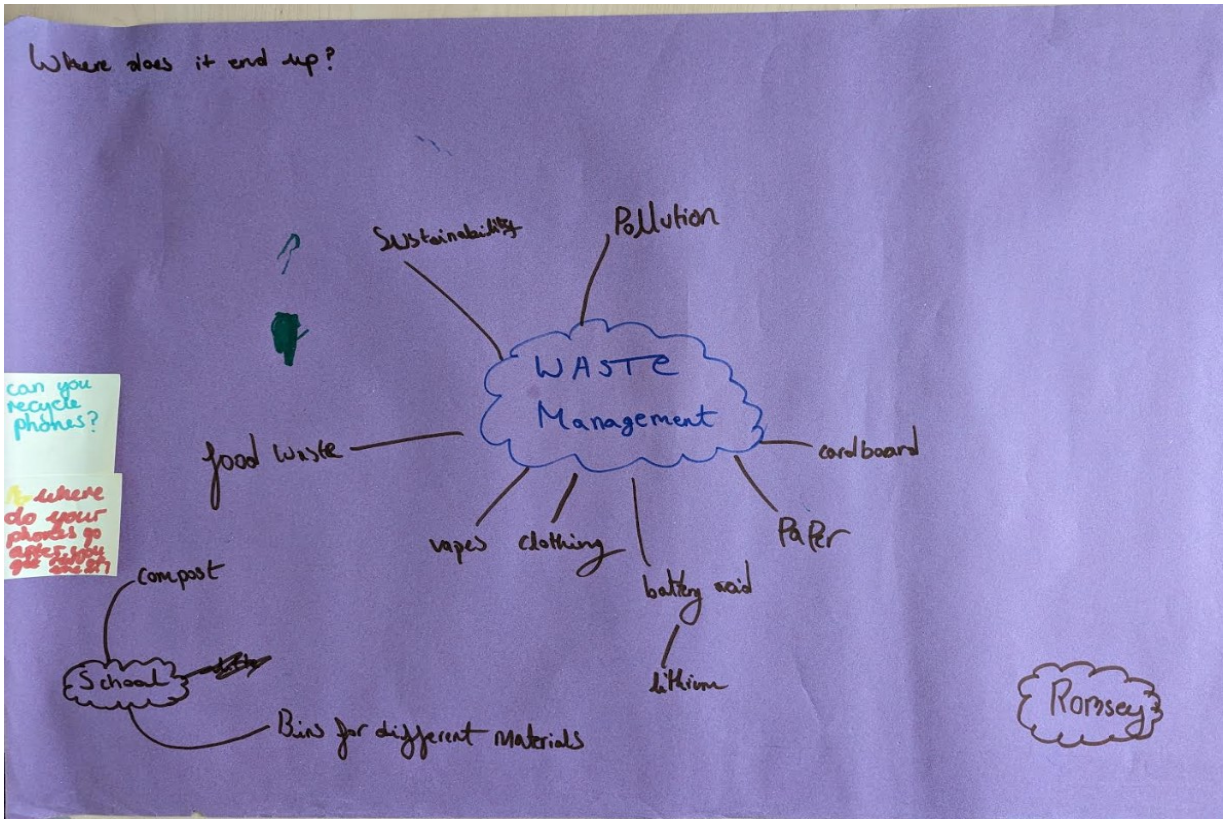
In conclusion, the COSMOS project offers significant potential to enhance education by fostering socio-scientific inquiry-based learning, promoting community engagement, and supporting interdisciplinary collaboration. Although challenges such as teacher workload, institutional resistance, and resource limitations persist, they can be addressed through thoughtful planning, sustained partnerships, and ongoing teacher development. By implementing these solutions, the COSMOS model has the potential to revolutionise education and prepare students to address complex socio-scientific issues in their communities.

5. Appendices

Appendix A

Appendix B


Waste Management @ Ramsey
Litter
Food waste
Questions
What happens at a recycling place?
Where do the binbags go? Aren't they made of plastic?
more bins everywhere
Recycling bins
teach us how to cut down on plastic use
Canteen Packaging
Teachers
Tutor time used for teaching us about the environment
lessons on sustainability more often instead of assemblies


Where does it end up?
Sustainability
Pollution
WASTE Management
food waste
cardboard
Paper
vapes
clothing
battery acid
Lithium
can you recycle phones?
where do your phones go after you get rid of them
compost
School
Bins for different materials
Ramsey

Appendix C

What should be done about waste management at our school?

Last week, we started discussing the issue of waste management and thinking about how to do this at school.
On the maps you created in your groups, you included many key players involved in the issue of waste management (teachers, pupils, canteen, community) and have already started thinking about solutions and making suggestions.
Today, we are going to research information on four key types of waste you have included on your maps: batteries, clothing, plastics and food.




As you move around each room learning about these four themes, start taking notes on:
What are the possible solutions for managing this type of waste?
What are important things/information to consider for each possible solution?
What are the advantages of each solution?
What are the disadvantages of each solution?
Use the following worksheets to help you take notes for each theme. We will be discussing this information and solutions once you finish your research on the four themes.

Name of group members:

What should be done about waste management at our school?

BATTERIES

Possible solutions	Important things/information to consider for this solution	Advantages of this solution	Disadvantages of this solution

What extra/additional information do you need to help you make a decision?

What is your group's top solution to the problem and why? (this solution could then be included on your poster)

What should be done about waste management at our school?

CLOTHING

Possible solutions	Important things/information to consider for this solution	Advantages of this solution	Disadvantages of this solution

What extra/additional information do you need to help you make a decision?

What is your group's top solution to the problem and why? (this solution could then be included on your poster)

What should be done about waste management at our school?

PLASTICS

Possible solutions	Important things/information to consider for this solution	Advantages of this solution	Disadvantages of this solution

What extra/additional information do you need to help you make a decision?

What is your group's top solution to the problem and why? (this solution could then be included on your poster)

What should be done about waste management at our school?

FOOD

Possible solutions	Important things/information to consider for this solution	Advantages of this solution	Disadvantages of this solution

What extra/additional information do you need to help you make a decision?

What is your group's top solution to the problem and why? (this solution could then be included on your poster)

Use this space to take additional notes if you need to.

 BATTERIES	CLOTHING 

Appendix D

The three top posters as voted by pupils and teachers during the SSIBL Science Day