Creating Organisational Structures for Meaningful science education through Open Schooling for all

D4.1 Report of SSIBL implementation within CoP, and reflections on facilitation, support and implementation within each participating Secondary school Round 1

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101005982

Deliverable Documentation Sheet

Title	D4.1 Report of SSIBL implementation within CoP, and reflections on facilitation, support and implementation within each participating Secondary school Round 1
Related WP	WP4
Lead Beneficiary	4-KU
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Consortium partners	1-UU 2-Southampton 3-KdG 4-KU 5-IE-UL 6-BBC 7-Euroface 8-Djapo 9-WSC 10-Ciencia Viva 11-Alma Löv 12-MoE
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Nature of the deliverable	Report
Dissemination level	CO
Date of submission	01-09-2023
Version	1.0

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Glossary

Alma Löv	Alma Löv Museum of Unexp. Art
BBC	Beit Berl College
COSMOS	Creating Organizational Structures for Meaningful science education through Open Schooling for all
CoP	Community of Practice
CORPOS	Core ORganisational Structure for Promoting Open Schooling
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
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
WSC	Winchester Science Center

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1. Introduction

This deliverable focuses on what has taken place within each participating secondary school in the COSMOS project during the first implementation round. The aim of this deliverable is to describe the implementation of the COSMOS approach, including CORPOS-SSIBL-CoP implementations and to present reflections on the facilitation, support and implementation process for each school. These reflections should serve as important feedback for the second round of implementation. The report includes four sections with the following content:

- Overview of CORPOS-SSIBL-CoP implementations during the first round.
- Narrative descriptions of CORPOS-SSIBL-CoP implementations.
- Reflections on facilitation, support and implementation within each participating secondary school.
- Lessons learned and next steps for implementations in the second round.

2. Overview of CORPOS-SSIBL-CoP implementations during first round

In this section, we present an overview of the CORPOS-SSIBL-CoP implementations during the first round in the form of tables. These show the number of schools that participated in the different countries, the number of teachers and students involved, the age of students, the types of members that were part of CORPOS and CoP and their respective roles. Additionally, the chosen SSIBL themes in each school/class are listed along with the length of implementation in each school/class. The overviews will be further elaborated in the next section.

In total, there were nine secondary schools involved in the first implementation round. Altogether, there were 40 secondary teachers and more than 500 students (most of them in the ages of 13-16 years) participating. There was one exception in terms of age; in Belgium, there were also students from vocational education programs involved and these students were up to 21 years old. See Table 1.

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Table 1. Overview of participating schools, teachers and students in each of the countries involved in the COSMOS project during the first round of implementation.

Country	Number of schools involved	Number of teachers involved	Number of students involved	Age of students (in years)
Belgium	2	12	87	14-21
England	1	4	120	13-14
Israel	1	8	120	13
Netherlands	2	7	23	14-15
Portugal	2	4	84	12-17
Sweden	1	5	120	14-15

In each of the participating schools CORPOS were established with teachers and other kinds of staff from the schools as well as staff from the Higher Education Institutions (HEI) and societal partners in the COSMOS project. Table 2 shows an overview of the CORPOS members and their roles in the different schools.

***Table 2.** Overview of CORPOS members and their role in each of the participating country and school.*
*The reason a primary school teacher was involved in the CORPOS in Portugal is because they work in school clusters with close collaboration between primary and secondary school.

Country and school	CORPOS members & role
Belgium - school 1	1 secondary school head teacher + 1 policy assistant of the school + 2 teachers + 3 staff from HEI partner + 2 staff from societal partner
Belgium - school 2	5 teachers of general courses in vocational education + 3 staff from HEI partner + 2 staff from societal partner
England - school 1	4 science teachers + 3 staff from HEI partner + 1 staff from societal partner
Israel - school 1	6 science teachers, one of them coordinator of COSMOS in the school + 2 staff from HEI partner + 2 staff from societal partner
Portugal - school 1	1 primary school teacher* + 3 secondary school teachers (one of them not fulfilling participation) + 3 staff from HEI partner + 1 staff from societal partner
Portugal – School 2	1 primary school teacher* + 2 secondary school teachers + 3 staff from HEI partner + 1 staff from societal partner
Netherlands – school 1	3 science teachers + 2 staff from HEI partner
Netherlands –	4 teachers (History, Chemistry, Culture, Gymnastic) + 2 staff from HEI partner

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school 2	
Sweden **School 1**	5 Science teachers + 1 staff HEI partner + 1 staff societal partner

After establishing CORPOS in each school in the different countries, the next step was to decide on what kind of SSIBL to cover and thus, establishment of CoPs based on chosen theme. Table 3 displays the selected SSIBL themes, duration of the implementation working with the chosen themes and the CoP members along with their roles.

Table 3. *Overview of chosen SSIBL themes in each country and school, duration of implementation and CoP members and their roles.*

Country and school number	SSIBL	Duration implementation SSIBL activities	CoP members & role
Belgium - 1	Various topics of concern to the local police	Appr. 12 hours in total (7 lessons á 100 minutes)	CORPOS + Local police member
Belgium - 2	Quality of drinking water	Appr. 12 hours in total (2 days)	Same as CORPOS
England - 1	Waste management and recycling	Appr. 7 hours in total (2 lessons à 50 minutes + 1 day)	1 Biologist, 1 Environmental expert from SOTON, 1 Geography teacher (pupil environmental group coordinator), 1 School Careers Advisor, School Head teacher, School Deputy Head teacher, Chair of Governors, Gateway Academy Trust, Chief Operating Officer, Gateway Academy Trust, School's Science Curriculum Leader, School's Site Manager and Senior Manager, Romsey Community Services
Israel - 1	The Jerusalem Gazelle Valley – development versus preservation	Appr. 15 hours in total (5 lessons + 1 full day conducted in the Gazelle nature reserve)	CORPOS + 1 science teacher also being a coordinator at the school + science team from the school (5 teachers and lab technicians) + 1

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			activist for the protection of the valley+ e parents
Portugal - 1	How to live in a planet that shakes? Are we ready for an earthquake?	Appr. 13 hours in total	1 specialist from Civil protection, 1 student belonging to the fire department,1 Portuguese Language teacher, English Language teacher, 1 Family member with knowledge of Mandarin Language
Portugal - 2	Biodiversity loss	Appr. 7 hours approx. for one group of students, 12 hours for the other group of students	1 entomologist (insects' expert) from Ciência Viva, Microplastics' experts from a Ciência Viva project, 1 Visual Education teacher and Plants' experts from local municipality
Netherlands - 1	Particulate matter – should fossil cars and scooters be banned from the city	Appr. 3,5 hours in total (3 lessons à 70 minutes)	Same as CORPOS, information collected from online data system of the National Institute for Health and Environment
Netherlands - 2	Did not fulfil implementation this school year. To be continued in the next round.	None yet	Not established yet.
Sweden - 1	Genetic modified organisms – good or bad?	Appr. 16 hours in total (6 lessons à 40 minutes and 2 full days)	Same as CORPOS

In summary, we conclude that the COSMOS approach was implemented in at least one secondary school in each country, and in some cases, in two schools. There is variation in chosen SSIBL themes based on the local contexts, as well as differences in the in duration of working with the SSIBL. Consequently, the composition of CoP members also varies.

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3. Narrative descriptions of CORPOS-SSIBL-CoP implementations

In this section, we present narrative descriptions of CORPOS-SSIBL-CoP implementations from each of the countries. The narratives are provided by the HEI partners in each country. As narratives they vary based on context and details presented. However, together they present a comprehensive picture of how the implementation of the COSMOS approach has unfolded during the first round.

3.1. Implementation in Belgium

Establishment of CORPOS

In both schools, to initiate and ensure the sustainability of the CORPOSs, we started from existing working groups ('science project week') and consultation structures ('teachers project STEM year 3'). Afterwards, we were building the initiation of CORPOS by creating common language at the start by using the openness wheel developed within COSMOS (Figure 1). Together, we identified the status of openness levels in the different parts of the wheel and where areas for improvement were desired. In addition, we made clear from the start that the Belgian societal partner Djapo would guide the schools and that the Belgian HEI, KdG was responsible for research activities. Throughout the school year, we continued to schedule regular sessions, to keep the importance of the project alive and not let it get lost in the delusion of the day. Nevertheless, we note that forming a CORPOS does not happen automatically and we need to put more effort towards the second round of implementation to make the project more sustainable in the schools.

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Figure 1. *Openness level wheel. Different dimensions of openness. Developed within Work Package 7 in the COSMOS project.*

Establishment of CoPs

For the initiation of CoPs, we started from existing working groups ('science project week') and consultation structures ('teachers project STEM year 3'). At both schools we worked in a similar way within the communities of practice: intake - kick-off - workshop - consultations - reflection/evaluation. The theoretical input we provided to the schools was also similar: SSIBL-CoP, forms of work to explore, research and take action on SSIs. For school 1, the local partner - the local police - was identified by the teachers. The students themselves determined the support organisations that they addressed during the neighbourhood investigation. For school 2, the process of identifying relevant stakeholders was more difficult. Due to the many innovations that the COSMOS project contained for them, this was less addressed in the project in the first implementation round. HEI (KdG) also did act as an external partner with expertise from secondary school teacher training on science education.

Selection of SSIBL theme

In selecting the SSIBL theme, we framed in our guidance what possible themes could be based on the Sustainable Development Goals (SDGs). Further selection proceeded differently at the two schools:

- School 1 started from the list of cases provided by the external stakeholder (the local police department). They decided that the final choice could and should be made by the students

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themselves. The project offered ways of working with the students to support them to make this choice and explore the themes further.

- At school 2, the teachers initially let the students decide which SDGs they wanted to work on, or what they were excited about. From this emerged the theme of "water", which fascinated the students and in addition, teachers also saw this as fitting into the educational goals they wished to achieve with the project. In order to determine a further focus, we looked at the fields of interest of the students on the one hand and at social challenges around the theme of "water" on the other. Based on these possibilities, we formulated some societal challenges regarding the theme of ‘water’.

3.2. Implementation in England

Establishment of CORPOS

Collaboration with the participating secondary school in England was initiated from a year 9 science teacher, (which will be referred to as the ‘lead science teacher’ in this report). The lead science teacher, studied for her teacher qualification degree at Southampton Education School, and had prior connections to the SOTON (Southampton University) 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 and the school.

During July 2022 (Month7, Initiation phase), an initial recruitment meeting 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. At the end of September 2022, all SOTON and Winchester Science Centre (WSC) partners attended an afterschool meeting for the focus group discussion on school openness and further discussion of project concepts with the science teacher team (three science teachers attended). 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 students. This meeting was the starting point for the establishment of the CORPOS team at this school.

Establishment of CoPs and selection of SSIBL theme

SOTON and WSC partners collaborated closely in developing and delivering the two TPD workshops that were organised during October 2022. We adapted the guidelines provided from Work Package 2, and used resources and materials shared by Work Package 5 leaders during Consortium Meeting 2 in Sweden to inform our Teacher Professional Development (TPD) workshops. In the first TPD workshop, we focused on discussing key concepts in SSIBL. We discussed SSIs that would be

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relevant to students and to the school team and conducted a stakeholder analysis to discuss who at the school would be interested to be involved (e.g., school careers advisor) 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. In this 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 students to be citizens of the future, and 'teaching them the skills to be able to make decisions in their everyday lives'. The discussion around the importance of addressing SSIs continued into this workshop, and as a result, the topic of waste management was selected as the SSI to explore collaboratively with students and the school community. This was based on the teachers' conversations with students, which indicated that students 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. By the end of the second workshop, we had discussed different elements of our SSIBL unit (Table 4).

Table 4. *Elements of inquiry discussed during TPD workshops based on the agreed SSI (waste management).*

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

We used these ideas to continue communication over email and had three further co-design meetings in person in preparation for the SSIBL to take place during *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 students and shared responsibility for preparing resources. For example, the lead science teacher drafted initially online questions for a students' homework task which we adapted and gave feedback to ensure it was asking a socio-scientific question. The teachers then gave further feedback on how to formulate questions to ensure students would understand them and be able to engage with the task. Figure 2 shows an example of task.

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Figure 2. *Example of online homework task for students related to waste and recycling.*

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 (and the Environmental Group coordinator) to co-design activities. Expanding the CoP to include external collaborators was a challenge due to several factors including potential stakeholders being unresponsive, or stakeholders being unavailable to attend meetings or the SSIBL *Science day*. 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

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presentation to all year 9 students taking part and another academic who specialises in food systems took part by supporting students with their investigations on Food Waste.

3.3. Implementation in Israel

Establishment of CORPOS

In Israel we selected the schools for the project via an open call. From dozens of responses, a handful schools were selected with whom we conducted two communication events (the first- long distance and the second – face-to-face). In these events we introduced the basic COSMOS method concepts, and the schools began thinking which teachers that would participate in the project. Based on these events we selected, via various criteria, a final group of schools (three primary and one secondary).

Once the schools were selected, prior to the first meeting with each school, they were asked to determine which internal and external members would be present in the first meeting with the COSMOS teams. The members that were present in this meeting constituted the initial CORPOS. In all the participating schools, the CORPOS also included two HEI COSMOS partners (rotating) and in the primary schools, also a societal partner from the Ministry of Education (MoE). Only COSMOS HEI partners took part in the CORPOS for secondary school.

Selection of SSIBL theme and establishment of CoP

The SSIBL theme was decided by school team at the recruitment stage (proposed in advance by the school principal) and the design of the learning process remained more or less unchanged throughout the process. The idea was to conduct a peak day at the natural reserve (Gazelle Valley). Some minor additions and adaptations were introduced during the following TPD sessions and meetings with the CORPOS and COSMOS coordinator, yet the design of the lesson plans was conducted by the science team from the school.

While attempts were made to expand CoP membership beyond the teachers and students and deepen the application of openness dimensions in the learning process, only a few parents joined the peak day. An activist was invited to talk about how she and other activists prevented the urbanisation processes that threatened the natural wildlife habitat. Additionally, homeroom teachers conducted before the peak day, a lesson about the natural reserve and the harms and challenges brought about from continued construction and urbanisation.

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3.4. Implementation in the Netherlands

In the Netherlands collaboration was started with two secondary schools, however, with different outcomes, with only one of the schools actually being able to follow the COMSOS COSMOS approach during the school year, the other school postponing the process because of internal organisation issues.

Establishment of CORPOS

We approached the first secondary school (Anna van Rijn college) using our personal network. The school was recommended by our societal partner (Universiteitsmuseum Utrecht). Several science teachers attended the CORPOS foundation meeting that we organised, where project objectives and processes were discussed. After this meeting, four teachers were enthusiastic to participate and joined the program. One of them went on leave after the CORPOS foundation meeting, meaning that we worked with three teachers in this school for most of the year. The CORPOS foundation meeting was followed by a second meeting, where we conducted the focus group interview and discussed the dimensions of openness with the teachers. The teachers insisted that they did not want a member of the school board to participate in the project. Our CORPOS therefore initially consisted of only the teachers and two HEI partners.

The other secondary school (Christelijk Lyceum Veenendaal) was also approached using our personal network. We knew this school from a previous project in which we collaborated. The school was enthusiastic to participate and joined the program. This secondary school wants us to help in the process that has already started in which they have involved local stakeholders as part of their curriculum/ learning trajectory. They are implementing a new learning trajectory (‘nieuwe leerweg’) for all year 9 and 10 students, in which students visit local enterprises, non-governmental-organisations (NGOs) and businesses, raise questions and do inquiry. The principle approved of this new learning trajectory, which would be implemented (pilot tested) in May and June of this school year (spring 2023). Our direct contact redirected us to the workgroup of the ‘new learning trajectory’. The teachers in this workgroup formed the CORPOS together with two HEI partners from the UU. Multiple online (n=5) and face-to-face meetings took place (n=3) to discuss the project objectives and process, but the school / workgroup was still struggling with internal processes in getting the new learning trajectory implemented and get the other teachers on board. However, in April, 2023, the school informed us that they postpone the implementation of the entire new learning trajectory to next school year. Hence, SSIBL-CoP implementation did not take place at this school during this round.

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SSIBL-CoP implementation

In the first school, we organised three co-design session of 1,5-2 hours to work on lesson plans during January-April 2023. During the first meeting, we discussed possible SSI's and reviewed various SSIBL teaching and learning activities to address these SSI's (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, teachers only incorporated learning activities for students to inquire different stakeholder but not involved external partners in their 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. We designed worksheets to help them in their lesson design and planning during these meetings and teachers gave feedback on the designs of the other teachers. We left the choice for both the SSI's and possible stakeholders with the teachers, since they wanted to link it to the formal curriculum. Topics chosen by the teachers: 'return of the wolves in the Netherlands', 'nitrogen crisis' & 'particulate matter' (air pollution). As HEI partners we were physically present to give feedback on the lesson plans and contribute with ideas on how to implement the chosen SSI and the various SSIBL steps into their teaching.

Even though we did go through all these steps, the teachers did not finish their lesson plan and timeline within the given time. They planned to finish these at home and send them to us. However, a complete lesson plan was only handed in by one of the teachers. Therefore, the written feedback that we planned for the finished lesson plans was not possible for all teachers. At this school, only one of the teachers taught the designed lesson this schoolyear. The other two teachers didn't due to personal circumstances, and plan on teaching their lessons next schoolyear. The teacher who taught the lesson did use one of the SSIBL teaching activities we discussed to introduce an SSI. Students then did research on part of this SSI. The data they collected was uploaded to the RIVM (Dutch institute for public health and the environment). However, an actual collaboration with this societal partner, apart from sharing data, was not present.

As already mentioned, the second school did not make it with establishing SSIBL-CoP implementation during this round. However, interesting about this school is that it already has multiple CoPs in place. These are local stakeholders (small enterprises, NGO's, businesses) which were involved in the school curriculum before. During our first meeting, which was instigated by the school, we were invited to meet with the societal partners that the school already worked with. One of the teachers presented their plans to the societal partners, explaining that they would like to discuss SSIs with their students while involving the societal partners in this discussion. They also introduced us as the ones who would be there to give support to teachers on how to implement SSIs in lessons.

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After this meeting, a second meeting to conduct the focus group interview took place. Teachers that were involved with one of the projects the school was already starting in cooperation with various stakeholders joined this meeting. During this meeting we discussed the dimensions of openness with the teachers that were present. During round 1 no workshops related to SSIBL and no implementations specifically related to the COSMOS project have taken place yet (got postponed by the school). The HEI partner (Utrecht University) joined a team of school teachers that visited firms and stakeholders that will be involved in the 'new learning trajectory' and will be part of the CoPs. Moreover, the HEI partner visited the 'inspiration market' that was organised for teachers at school in preparation and orientation of the new learning trajectory next school year.

3.5. Implementation in Portugal

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 educational project they consider adequate for their social and cultural reality. In the COSMOS project we are working with two school clusters. Each cluster is represented in by 1 primary school and 2 classes (and 2 teachers) of 1 secondary school. This way, sometimes it is hard to individualise the work developed in each educational level because they were working together in the development of COSMOS. However, below you will find narratives of how we consider the establishment of CORPOS and also the SSIBL-CoP implementation.

Establishment of CORPOS

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

The CORPOS was maintained/supported by the strong collaboration and the shared culture/interest (between the IE-ULisboa team and the main teacher from each school cluster) in terms of the importance attributed to inquiry and activism initiatives implemented by students and teachers. As

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already mentioned, this culture has been developed during a long process of collaboration (13 years) associated with a CoP centred on that kind of initiatives. The contacts with the CORPOS were established both through videoconferences, phone calls to the main teachers involved and visits in person to the schools by IE-ULisboa members.

SSIBL-CoP implementation

Due to the Portuguese specific context (marked by strikes from the school teachers and workers, and a big workload), we used a more condensed structure, respecting the three conceptual stages, but just 4 hours long. This way, we dedicated less time and discussion to these components. The presentation of COSMOS (project and approach) and the participants, together with the school-cluster characterisation regarding openness attributes, took us around one hour. A period of 1.30h approximately was dedicated to SSIBL, the problem selection and the definition of possible activities. Perhaps, the phase to which we dedicated more time was the reflection about: a) the COSMOS implemented activities; and b) the factors affecting in a positive or a negative way the levels of different of school-openness dimensions (1.30h).

The number of teachers was not the same during the entire project, with some of them being more involved in specific phases (teachers from other subjects collaborating in specific tasks – e.g., Visual Education teacher in this cluster). However, in each cluster we had a least a group of three teachers (1 primary and 2 secondary) that participated in all phases.

The COSMOS approach was presented based on concrete examples of students' actions taken from our previous CoP (the one that we have been supporting for 13 years). The previous experience of some teachers with a very similar approach facilitated the understanding of the total approach.

The SSIBL theme (biodiversity loss) was decided mainly by the school teachers of the CORPOS, based on their knowledge of the curricula of the different school levels of education and subjects involved. All the activities were developed mainly by the teachers' group, with a high degree of independence from the other CORPOS members. The intervention of both IE-ULisboa and Ciência Viva members were mainly through the suggestion of possible activities and collaborations. However, one entomologist from Ciência Viva had an important role through the organization of a practical workshop for students about the role of insects in the ecosystems. This workshop took place in a big science centre that the students had the opportunity to visit.

The selection of members for the CoP was done mainly by the teachers and according with the specific context resulting from the selected theme by each school cluster and the strikes that were happening during that period. Other CORPOS members had an important role suggesting possible

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collaborations, discussing/improving the planned activities with the teachers and supporting teachers and students through local visits to the classes where the activities were being implemented.

3.6. Implementation in Sweden

Establishment of CORPOS

For many years, Karlstad University has maintained a network with schools in the region of Värmland in Sweden. This region comprises 16 municipalities, encompassing approximately 30 secondary schools. Various activities take place every year including TPD activities, joint research projects and activities to stimulate interest in STEM among students of all ages. For the COSMOS project, contact was made with one secondary school (Ferlin school) which had previously collaborated with our societal partner, Alma Löv. The science teachers at the school were approached via email asking for their interest in participating in the project. An online meeting was held with the teachers and their principal during the autumn of 2022 informing them more about the project and discussing practical plans of how and when to start working together. Some email contacts followed and then the first TPD and planning meeting was held in February 2023, this time with two of the science teachers from the school, taking a lead of the project in the school and acting as coordinators. During this meeting (lasting for about a half day) we discussed the COSMOS approach and worked with the openness level wheal (Figure 1). Working with SSIBL was not new to the teachers, hence not so much time was needed to spend on TPD from this aspect.

In addition, in all schools in Sweden teachers work in teams, together with other school staff and CORPOS is therefore already in place, at least in Värmland where we also have a tradition of collaboration between the schools and the university; in this particular case, also with Alma Löv as a societal partner.

SSIBL-CoP implementation

With CORPOS in place and the first initial meetings with the science teachers and the principal the teachers continued by talking together at the school about what would be a suitable SSI for them to focus on based on their curriculum. They wanted to focus on Genetic Modified Organisms (GMO), since this would fit in with the topic of genetics that their students were about to start to work on at the end of the school year. Hence, the ASK part of SSIBL was decided by the teachers and was formulated as “Are GMO something good or bad?”

After the first meeting (online) with the two science teachers and a representative from Alma Löv co-design of some of the planned activities took place. The teachers themselves had decided upon some

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of the activities with support from the HEI partner. The FIND-OUT part of SSIBL included five lessons with some basics, what is DNA, what is a gene and what is meant by GMO. This was followed by a whole day at Alma Löv for the students and the teachers. During this day they worked with GMO using art-based inquiry methodology. This is was followed by a full day at the school when the students created art-objects related to GMO with some of the objects portraying positive aspects while others presenting more critical outcomes. The concept of working with GMO using art-based inquiry as a strategy is explained more in depth in a research publication by Raaijmakers and colleagues (2021). Finally, the ACT part of SSIBL was organised as lessons where the students had debates about the good and bad about GMO. The plan was also to arrange an exhibition at the library in the municipality with the art-works created by the students to share the students' perspectives on GMO with the public. However, the school term was now finished and summer holiday started, so this was postponed. In figure 3 below some pictures of the students' creations are shown.

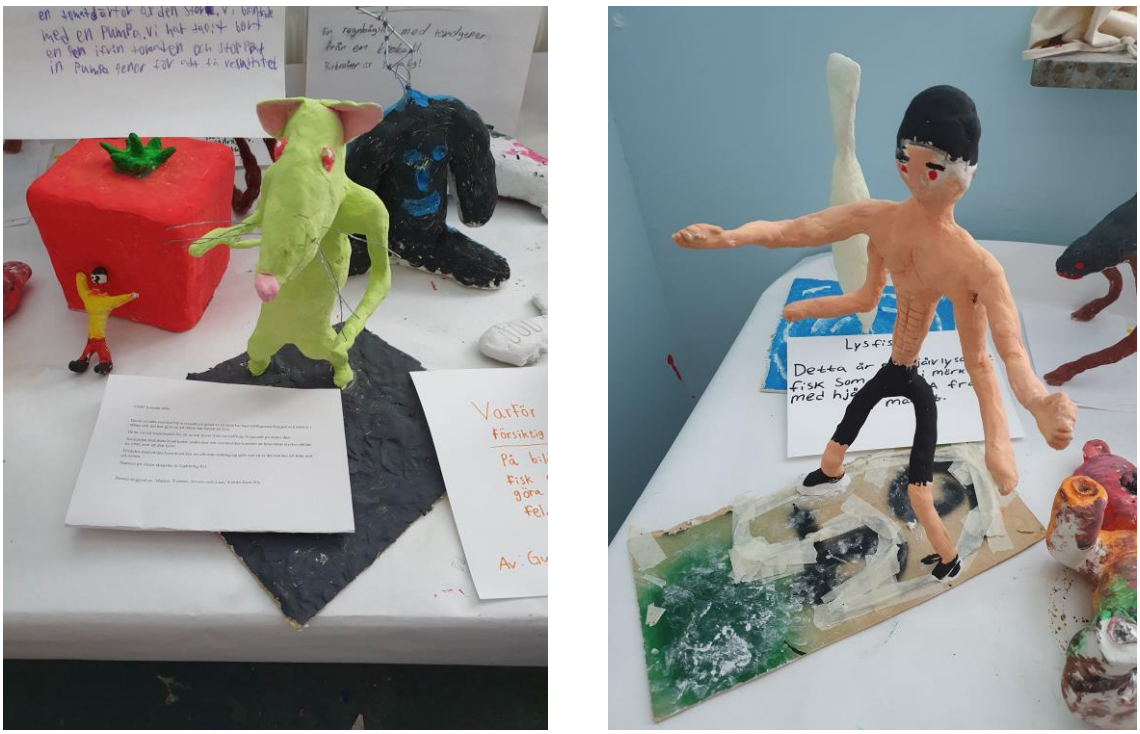

***Figure 3**. Examples of creations made by students showing GMO.*

Except for the collaboration within CORPOS no CoP was implemented. Some reasons for this could be lack of time (working with the project at the end of the school term) and also lack of contacts working directly with GMO. However, the teachers wanted to follow up the project at the start of the following school term and it is possible that future contacts may be established.

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4. Reflections on facilitation, support and implementation within each participating secondary school

In this section we present the reflections on experiences from the different countries where we have implemented the COSMOS approach in participating secondary schools and how this was facilitated and supported. Here, as well as with the presented narratives presented above the length and details presented from each country varies. However, in the final section of the delivery report, the overall experiences and lessons learned from implementation during the round will be summarised.

4.1. Experiences from Belgium

Overall, we can report that one round of implementation proved too little for the sustainable installation of a CORPOS in our schools. We followed the different steps of the COSMOS framework, with the last step only receiving explicit attention at the end of the project. During the project and preparation in the CoP, little additional attention was paid to this. We did note throughout the guidance that when the schools involved the experience within the project as a 'win' from the guidance offered, it is no longer a hindrance to ask for certain extra efforts (e.g. research activities).

CORPOS

In school 1, the principal and policy officer were present during the kick-off, but did not join afterwards. During implementation, it turned out that gaining experience starting from SSIs and involving the school environment was already sufficiently innovative for the teaching team. The enormous workload and periods when the teachers involved did not always see the added value of the project also made it difficult to take steps towards a CORPOS. Naming this situation and sufficient personal contacts did help us through this. Partly because of this, building a CORPOS still appeared to be a step too far within this first implementation round.

In school 2, the management was only present at the introductory meeting. From the interviews with the teachers, this did not prove detrimental to the process as the teacher team indicated that they felt very centralized leadership and could not speak freely in the presence of the management. Even at this school, the SSIBL-CoP pedagogy and teaching of science lessons was innovative enough for the teachers involved. Building a CORPOS remains possible in the second year of implementation.

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CoP

While initiating and supporting CoP, we did note that when the schools involved the experience within the project as a 'win', it is no longer a hindrance to ask for certain extra efforts (e.g. research activities). A success factor of the CoP was the ownership of the project with the students that remained with the teachers themselves at all times. In this way, we also achieved the highest levels of participation where the participants made and organised decisions entirely by themselves. We only acted as facilitators and provided new insights or asked critical questions. At both schools the process started rather slowly, but as soon as the planned projects got closer in time, the functioning of the CoP was considerably accelerated.

In addition - due to the enormous workload and periods when teachers did not always see the added value of the project – the teachers of school 1 sometimes found it difficult to take steps forward in the guidance and design of the project. As mentioned earlier, the fact that we named this and were able to maintain personal contact helped us through this.

For school 2, the fact that we were pursuing such high levels of participation did also cause the SSIBL-CoP approach to no longer always be guaranteed. For example, any link with the school's environment or other stakeholders was missing, ourselves not taken into account. In addition, we noticed that CoP members mainly used their own complementary competencies. Thus, there appeared to be little time in the first year of implementation to learn from each other. What did prove to be successful at this school was the fact that they were given time - during working hours - to work on this project which also allowed them to fully enjoy the guidance offered. The fact that HEI as an external partner offered input around science education & conducting tests appeared to accelerate the functioning of the CoP.

SSIBL-CoP design & implementation

Overall, we note that there was limited time for evaluating the project's stated objectives with the schools. What was successful was the moment when the given input was incorporated in the final project with the students and the moment when we observed the project with the students.

In addition, for school 1, the fact that the students themselves were also allowed to be very participative proved to be a success factor. As was the fact that the research - with which the students of this school are familiar - are linked to social issues.

In school 2, not all teachers who would participate in the project with the students were involved in the CoP. The teachers of the CoP therefore organized a morning session to explain to all the teachers the

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process they had gone through and to go step by step through the project they would carry out with the students. Even while the project was running, the design team remained available for questions, and at least one of them was always present to help as well. Although the three phases of SSIBL were present in the project, they came up interchangeably and multiple times over a two-day period, so the logical structure was sometimes lacking. The broader framework - especially during the FIND OUT phase - was also sometimes difficult for the students to recognize. In addition, the link to the school environment or external stakeholders was missing. This proved to be a step too far for this school this year. This focus remains a major focus for next year. In addition, due to the limited time of the project, less student participation was possible.

Role of school leadership

In both schools, the principals and a policy member were involved in the start-up of the project, but were on the side-lines afterwards. The principals of both schools supported the project and indicated its importance and added value.

The management of the first school was more closely involved in the start-up and also gave some suggestions there to cooperate with a teacher of another subject. She was actively involved at the beginning of the project. The policy officer involved supported the teachers in shaping the project and monitored progress - in the background.

For the management of school 2, it was only the introduction and afterwards he put the process in the hands of the teachers in charge. The policy staff involved, who also have dual roles as teachers, were active members of the design group and also helped implement the project themselves. The fact that in this school the teachers were already grouped together in a project group and were scheduled free on Wednesdays did facilitate the process greatly. Some teachers on the team did say after the project that they really missed the support of the management after the project. The project was very time-consuming and recognition for hard work - which was desired by the teachers involved - did not follow.

Reflection on the overall experience of all of the different participants

The teachers of school 1 were often hesitant to participate in the different steps of the process and were sometimes less motivated. 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.

The team of school 2 was very enthusiastic and positive. The way of working was new for the participating teachers, except for one. The other teachers wanted to move forward more quickly at the start but afterwards also saw the value of following the process step by step. The principal already

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indicated that he would like to see (even) more results from this substantial time investment among the teachers involved toward next year. He expects the elaboration of a completely new project.

4.2. Experiences from England

Reflections on CORPOS work

Overall, the collaboration and professional relationship we have established between SOTON/WSC and the participating school as well between us (SOTON and WSC partners) has been a key strength and positive outcome of the work we have conducted 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.

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 remaining of the project implementation at school. Two CoP members (careers advisor, Geography teacher) collaborated with CORPOS in the co-design and implementation of SSIBL activities (ASK, FIND OUT, ACT stages). Other CoP members, such as the school head teacher and the school site manager, although supportive of project activities, they were less involved and interactions with these members was 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 Students 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

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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 implementations 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 students' 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. For example, the students 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 students that such a provision already exists at the school at an informal basis (e.g. the students 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 students most in need), but the school was worried about the stigma that such a shop might bring for students from disadvantaged backgrounds. However, through discussion with students it was clear that they 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 students a voice during this communication event allowed school management staff to listen to and to better understand students' perspectives on this issue.

Reflections on SSIBL-CoP implementation

The main success of the approach taken for our SSIBL-CoP implementation was the fact that a large number of students from the same year group were able to participate in a fully interactive science day, where they had to research resources on four themes (see Appendix) co-designed by CORPOS, 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 the key SSI question was formulated by CORPOS during the CPD workshops where we discussed various SSIs that would be of relevance based on students' interest (e.g., using & recycling gadgets and batteries). It was also of importance to consider what was of interest to the local community (e.g., food waste and food management), and for our teams (e.g., socioenvironmental issues such as climate change, biodiversity loss and issues around sustainability). The SSI question was then presented to students through an online homework task in order to express their knowledge and views on the issue, which in turned informed the four themes chosen as a focus for the SSIBL Science Day.

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The key challenge we encountered during SSIBL-CoP implementation was embedding SSIBL-CoP in the science curriculum, which in turn influences how our approach in this school can be sustainable for a longer term. The four science teachers we worked with were committed to the project objectives however they had limited time for additional planning and so it was agreed that the main SSIBL-CoP implementation time would be given in one whole day of teaching about the chosen SSI (waste management and recycling). The planning of this day was initially planned to take place near the time of the British Science Week 2023 (British Science Week, 2023), a week dedicated nationally to doing science related activities. The fact that project activities took place outside of normal curriculum time meant that lessons were not embedded in the curriculum.

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 students 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 the school; 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 students their proposed solutions and pointed out the importance of such activities for impactful learning and citizenship development.

4.3. Experiences from Israel

Reflections on CORPOS work

The TPD sessions constituted the main forum for communicating COSMOS ideas to the CORPOS and school teams. Additionally, ongoing communication was maintained by HEI representative with the COSMOS coordinator in school, to promote the implementation of the CoP. In the TPD sessions and meetings, the CORPOS members were active, the themes discussed (openness dimensions, SSIBL, learning as a community) were well received and instigated a lively discussion in which experiences were shared. In the case of the Gymnasium, the main challenge we encountered was the low motivation to engage in meaningful COSMOS activities and process by the CORPOS team, which was probably due to the lack of involvement of the school principal, the lack of communication regarding COSMOS in the school, and time constraints for leading change processes and creating a

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meaningful CoP. Several attempts were made to promote the principal's involvement and to increase motivation in the TPD sessions and meetings, yet the school team had no real incentive to expand on existing activities. The organizational culture of the school did not encourage innovation even though additional financial support was provided by the MoE.

Reflections on SSIBL-CoP implementation

The SSIBL theme that was chosen had great promise for promoting a meaningful CoP. During the TPD sessions, some ideas were introduced that could have expanded CoP membership and actions, yet these were not realised. The participation of the CoP members almost exclusively limited to the science education team, and particularly to the science coordinator. Teachers were involved mostly at the Peak Day activities, but not in the selection of the SSI and the design of the learning processes. Again, there were no real attempts to create a meaningful CoP and SSIBL stages, and this can be explained by the absence of all the identified success factors. Most notably, the absence of leadership (at the school and science team level), and misallocation of hours for regular CORPOS meetings for promoting CoP activities. Identification with the COSMOS ideas seemed high, yet the organizational culture and general disinterest to engage in the process did not produce expected results. It should be stressed that scheduling difficulties (weather conditions that dictated options for out-door learning in the Gazelle valley) also played a part, restricting the time to engage in more meaningful CoP processes. An additional factor that might have played a minor role was the geographical distance of the school from COSMOS team members. It is advisable to work with more closely situated schools. As a result of all the above the three stages of SSIBL were not significantly realized, particularly the ACT stage which was generally absent. Attempts by the COSMOS HEI team to build on the Peak Day activities for further learning and CoP building were not successful and were resisted.

4.4. Experiences from the Netherlands

In creating a CORPOS, we initiated meetings with the teachers, introducing COSMOS, the goals and timeline of the project. We had an enthusiastic group of science teachers at school one, but the teachers insisted that they did not want a member of the school board to participate in the project. Our CORPOS therefore consisted of only three science teachers and two HEI partners.

In fostering the SSIBL-CoP implementation we organised three co-design session between January and April 2023, of 1,5 -2 hours to work on lesson plans with the science teachers of school one. Below we show a summary of what took place during the three meetings we had with the teachers.

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- We initiated a first meeting with the teachers to discuss possible SSI's and review various SSIBL teaching and learning activities to address these SSI's (training workshop SSIBL).
- During a 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 teachers only incorporated learning activities for students to inquire different stakeholder but not involved external partners in their lesson plan, as such not really initiating a CoP.
- During a third meeting the teachers could continue working on their lesson plan, while also working out a timeline for the implementation of their lesson plan.

We designed worksheets to help the teachers in their lesson design and planning during these three meetings and the teachers gave feedback to each other on the designs of the lesson plans. We left the choice for both the SSI's and possible stakeholders with the teachers, since they wanted to link it to the formal curriculum.

So, at school one we discussed all the steps that are part of SSIBL. All teachers thought of how to implement these steps when addressing their SSI of choice using a worksheet that we developed. We saw that teachers were very enthusiastic about incorporating SSIs into their teaching. This led to them being very open to different types of SSIs to discuss in their lessons. Mostly focusing on ASK and FIND OUT, ignoring ACT. So, not all steps that belong to SSIBL were obviously present in this lesson series.

As already mentioned, activities in school two were not taking place as originally planned, due to the new organisation at the school.
In summary, the experiences from the Netherlands are presented as lists of success factors and challenges:

Successes

- At school two, there were already CoPs in place that theoretically can be used when implementing teaching activities related to the COSMOS program (next round).
- At school one, teachers were very enthusiastic about incorporating SSI's into their teaching. This led to them being very open to different types of SSI's to discuss in their lessons
- Teachers really appreciated the workshops we provided on SSIBL pedagogy and suggested learning and teaching activities for the different stages. They all favoured the 'arguments in motion' activity

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Challenges

- The teachers at school one didn't want to involve the school principal, also not after we (HEI partner) volunteered to talk with them and involve them. They indicated that the principle/ school leadership approves and applaud that they join the COSMOS project, but does not facilitate them (e.g., time in their schedule, less other tasks).
- Involving external partners was a step to far for the teachers at school one. Changing their lessons according to SSIBL pedagogy, linking it to the curriculum and plan it in the regular schedule was already challenging.
- Teachers struggle with having enough time. This time restraint is present in two ways. First, when they are working on the COSMOS Project designing their lesson, which has to take place after school hours. Second, when trying to implement the designed lesson in their curriculum, which the teachers experience as already being overloaded. This resulted in only one of the three teachers really implementing the co-designed lessons this school year.
- School two has school leadership on board since they initiated the 'new learning trajectory', however getting all the other teachers on board is a challenge for the school / workgroup which made them postpone the implementation to next school year. In practice this resulted for COSMOS that CORPOS meetings and workshops were rescheduled over and over, meetings getting postponed and then cancelled. Setting appointments was a real challenge with this school.

4.5. Experiences from Portugal

Reflections on establishment of CORPOS

In Portugal, we involved groups of teachers with a long experience of collaboration in the implementation of activism initiatives based on an inquiry-based science education approach. The communication was established through our previous channels: video conference, phone calls and visits to the schools. The CORPOS was created, maintained and supported by the strong collaboration and the shared culture/interest (between the IE-ULisboa team and the main teacher from each school cluster) in terms of the importance attributed to inquiry and activism initiatives implemented by students and teachers. As already mentioned, this culture has been developed during long process of collaboration. So, we were quite 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; d) have positions of leadership regarding pedagogical innovation and project implementation in schools.

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Still, we faced some obstacles to CORPOS development: a) teacher 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) only a reduced number of teachers wanted to participate in the project.

Reflections on SSIBL-COP implementation

The SSIBL-CoP design and implementation was quite facilitated by 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 CoP development was possible due to the previous 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 CoP was facilitated by the previous experience of collaboration between different school levels and between schools from the same cluster. However, the collaboration with external institutions or groups was quite affected by the strike and the consequent "reduced mode" implemented by schools. The ACT phase of SSBL, was also affected by the strike and the suppression of several classes and action initiatives. Despite this, all the SSIBL stages were accelerated by students' enthusiasm, in spite of the implementation of the majority of COSMOS' activities at the end of school year, when they have a lot of work and are already tired.

The school leadership of each school had the important role of supporting teachers and students' involvement and participation in COSMOS. They were not directly involved, but they didn't create any obstacles.

Altogether, the COSMOS implementation was received quite well in both schools' clusters. Students enjoyed a lot the activities and the learning component was evident. Teachers mentioned that they always appreciate collaborating in this kind of projects because this allows them to gain more pedagogical knowledge and to continue implementing activities combining science education, citizenship education and school activism.

4.6. Experiences from Sweden

Reflections on establishment of CORPOS

This part of implementing the COSMOS approach was easy since teachers in Swedish compulsory schools already work in teams. Furthermore, collaboration between schools in the region of Värmland where Karlstad University is situated is since many years well established. The teachers had support

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from their principal to join the project and in practical issues of organising the full day activities. The principal also joined two of the meetings with the HEI partner during the implementation round. In addition to the established collaboration with the university, the school already had previous collaboration with the societal partner Alma Löv. All this together served as a great foundation for establishing CORPOS.

Reflections on SSIBL-CoP implementation

All stages of SSIBL worked fine. However, even more time would have been great to further work with the chosen SSI theme GMO, but the school year ended. The teachers have already decided to continue the work when the next school year starts again. Besides the collaboration within CORPOS, with co-design of the activities no additional partners were included to further extend the CORPOS to a CoP. As already mentioned, this was both due to lack of time, but also in difficulties finding stakeholders within the chosen SSI. Still, the overall reflection is that the implementation was considered as successful and all involved, including the students appreciated to be part of COSMOS. Some comments from students and teachers are presented below:

”I wish we could work more like this. To go outside of school is very inspiring and it makes learning more fun!” (Student comment after a day at the Alma Löv museum).

”To work this way is so good for the students. As a teacher I also become more inspired. The challenge is always the lack of time.” (Teacher comment).

”I think it’s great if we can collaborate even more with society, it’s good for people in the society to also find out what we do in school.” (Teacher comment).

5. Lessons learned

In each of the countries, lists were compiled detailing lessons learned, particularly focusing on the areas of improvement in the next round of implementation. These lists are presented, and subsequently, we summarise the collective lessons learned that need to be taken into account in the next implementation.

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5.1. Lessons learned from Belgium

- We experienced the need for clearer agreements between the different partners and HEI/SP. We need to communicate this not only internally (between HEI and SP) but also to the schools. Hereby we do not lose sight of the relation with the division of tasks CoP/CORPOS.
- All communication in between different sessions were by email. This did not work for all participants. We therefore plan to ask next year in advance (during introductory meeting) in which way they prefer to communicate in between: e-mail, telephone, WhatsApp message ...
- In this implementation round, the kick-off (intake with Djapo) and the focus group took place separately because otherwise the session would take too long. In retrospect, there was still a lot of overlap between what happened during those two moments, so we should take this to next year - also in function of feasibility for the schools - together.
- During the process there was sometimes confusion and lack of clarity about the expertise of HEI and SP, next implementation round we will clearly communicate from the start who has expertise in what.
- At both schools there was a phase when motivation dropped because the process seemed too slow. We resolve to make the SSIBL theme more concrete faster, or let the students choose it and always start from strong examples.
- The focus of cooperation with external stakeholders also deserves more attention. We also need to offer the teachers more tools in this area, because in this implementation round this did not seem as obvious as we initially expected.
- To increase student participation even more - and thus hopefully also learning gains - we strive to involve students earlier in the process. The students involved should also be the ones who will participate in the project / series of lessons / theme day / ...
- If it is an added value and possibility, we would also like to propose co-teaching to strengthen our support also during the project with the students.
- Our experience from the first round of implementation allows us to be clearer from the start about the expectations and progression of a participation in the COSMOS project.
- When we start observing students during the project, we need to be clearer about our observation questions. That way, teachers certainly don't feel controlled, but know that we are there from a supportive & investigative role.
- We are committed to using and applying SSIBL-CoP pedagogy more thoughtfully. Already at the introduction we question what frameworks the schools are working with, so we can look for links to teachers' and students' prior knowledge.
- The CORPOS is a bit mystical. It would be helpful if we could provide examples of a CORPOS so that we can better support and inspire the schools.

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- If SSIBL is new to the teachers, then two rounds of implementation are needed to put the CORPOS on the agenda. No too much innovation at once.

5.2. Lessons learned from England

- It is important to further engage with school leadership in order to provide the buy-in and support needed to allow classroom teachers to take risks and implement new approaches within their teaching time. We intend to work more closely with school leadership in order to maintain more personal communication with them and inform them about continuous implementation actions, and our lessons learned from the first round of implementation.
- There is a need to focus on how to embed SSIBL-CoP into the curriculum in order to make the COSMOS approach more sustainable. In order to achieve this, we have discussed this issue with participating teachers already and we have identified the barriers to curriculum integration (e.g., lack of time for planning new resources for a new lesson sequence).
- Our approach with discussing with CORPOS and exploring SSIs that are relevant to both the school community and to the students have been effective, and we will adopt the same approach when selected a SSI for the new unit developed.
- We will invest more time in networking earlier in the second round of implementation timeline in order to allow CoP members to be identified and more fully involved in the design as well as implementation of SSIBL-CoP activities.

5.3. Lessons learned from Israel

- School leadership - the importance of leadership, especially the involvement of the principal in the various stages – from the selection of SSI to the creation of the CoP. The engagement of the principal in the CORPOS is a significant success factor. Working with the principals – and not only with the teaching staff, on the openness dimensions – and perhaps particularly on ‘shared governance’ - may prove to be important for enhancing the various openness dimensions of COSMOS in the second round.
- Learning in/as a community – CoP – co-design - school teams seem to regard external stakeholders more as ‘external’ or instrumental partners rather than partners in collaboration. We intend to engage schools in the second round to conduct more meaningful co-design processes with CORPOS members (which also perhaps can be expanded to include ‘external’ community members), selection of the SSI, and apply a more open-community approach to the different SSIBL stages.

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- Depth of addressing SSIBL pedagogy - closely related to the previous lesson, each SSIBL stage can be made more meaningful in terms of the way the SSIs are selected, deciding on the driving question and the rest of the co-design process. A rich driving question will lead to diverse directions of inquiry. The ACT stage is arguably the most difficult to realise in formal school settings. These elements will receive more attention in the second round.
- The resource of time - in terms of timeframe, time allocation and scheduling, we are aware that the actual implementation stage of the CoP did not have sufficient time in the first round. The lack of sufficient time for implementation, due to the relatively late initiation stage and relatively lengthy TPD process, needs to be addressed in the second round. We intend to begin working with schools much earlier – from the beginning of the school year, so that more implementation time is afforded, and more time for COSMOS routines can be scheduled before and throughout the implementation process.
- Organisational culture of open schooling - the CORPOS element, and generally, the school-wide organisational aspects certainly can be expanded and enhanced. Working more closely with CORPOS members and supporting the school in expanding or diversifying CORPOS membership is an objective that we have set for ourselves in the second round. Close work with the principal as well as other members of school leadership can promote expanding openness at the school-organisational level.

All these aspects will be addressed in the second round with continuing schools. They will guide how we work with the new school, although in our view, experience gained by a school in a first round of implementation provides the foundations necessary for effectively addressing the school organizational and sustainability-of-process aspect of COSMOS.

5.4. Lessons learned from the Netherlands

- Ensure engagement and continuity by establishing a schedule for COSMOS meetings with the CORPOS before the beginning of the school year. At school one teachers struggled with scheduling time for COSMOS and at school two meetings were postponed or cancelled many times. We therefore scheduled fixed times for COSMOS in teachers schedules already for next school year. We are planning meetings with the principle to introduce ourselves and the COSMOS project and not only depend on the teachers to introduce COSMOS to the school leadership.
- Continue with the same schools for round two. Getting the Open schooling process started in the mind-set of teachers and school leadership as well as practical organisation in aligning it with the curriculum and planning co-design sessions needs time. Round one is needed for

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getting this process in place/started; teachers want to continue to harvest in the second round. Moreover, mastering SSIBL pedagogy (and a different view to teaching science) takes time. More emphasis will be in the TPD workshops on involving external stakeholders.

5.5. Lessons learned from Portugal

- Next year, all the process will begin much sooner than this year, in order to allow a much calmer and better planned implementation of COSMOS activities. Together with all the teachers from the school cluster, the CoP decided to begin the next year activities around the beginning of October.
- The CoP decided to make an effort on increasing the participations/involvement from external community members. This year, many planned activities were not implemented due to strikes affecting the normal school functioning.
- The CoP also decided to make an effort on increasing the number and range of action initiatives in the community around the schools. This year, many planned activities were not implemented due to the strikes and the consequent suppression of several activities planned for those days.
- The CoP members became conscious of their school cluster limitations regarding the level of openness to community. So, they decided to focus next year efforts in improving the connections and collaboration with external members of the community.

5.6. Lessons learned from Sweden

- It is probably more difficult to work with implementation at the end of a school year when many things are needed to finish. Implementations in the second round will therefore take place at the beginning of the school year.
- The choice of SSI theme is of importance in terms of also finding suitable partners from society to involve in CoPs.
- The school leader in this round was very supportive and engaged, this was a success factor and we will have emphasis on this also in the second round.

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6. Summary of lessons learned and recommendations for implementation in the next round

As presented in this report, all partners involved in Work Package 4 completed the first round of implementation and collaborated with at least one secondary school testing the COSMOS approach. This was conducted either via already existing networks/contacts, or as in the case of Israel via an open call to schools from MoE. In all countries, a number of meetings were held with the HEI partners, societal partners, and staff from schools. In some cases, additional partners were also involved in creating CoPs working with chosen SSIBL themes. The SSIBL activities were chosen based on the local contexts, either ongoing projects in the local area or connections to curricula. Summarising the results from each of the countries after the first implementation round there were notable success factors that we will continue as foundations for work in the next round as well as some factors that need to be strengthened.

6.1. Overall successful experiences

The overall successful experiences from the first round of implementation were identified into the following themes:

1. **Teacher Engagement and Investment** – the engagement and dedication of teachers were found in all countries. Most teachers were very engaged and invested a lot of extra time and effort in the project.
2. **Teacher empowerment and decision-making** – the importance of allowing teachers to make decisions, focusing on their expertise and ownership was another key to success.
3. **Student ownership and engagement** – students were engaged and positive during the implementation, expressing a desire to continue with similar activities.
4. **Implementation of the SSIBL approach** – in almost all cases, all of the steps of SSIBL were followed and enhanced through community collaboration supporting the effectiveness of the SSIBL methodology.
5. **Balancing school needs and project requirements** – another key to success is to find the balance between school needs and project requirements, keeping teachers motivated and not overloading them. Hence, the extent of work within the project must be allowed to be adapted to the local conditions.

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6. **School leadership support** – the significance of explicit and active support from school principals is a key to success of educational initiatives. This varied in the different countries, in one case the teachers did not want to have the school leader involved.
7. **Alignment with National Curriculum** – familiarity with SSIs related to the national curriculum facilitated the implementation. This was especially emphasised in the Swedish context. However, in all countries the importance of aligning innovative approaches with established curricular standards is argued as a key to success.
8. **Collaboration withing CoPs** – collaboration between schools, particularly in Portugal, and the role of already existing CoPs were identified as a key to success, not needing time for establishing CoPs.

In summary, the themes revolve around teacher and student engagement, effective implementation of SSIBL, maintain a balance between educational needs and project goals, empowering teachers and students, the role of school leadership and collaboration, and the alignment with existing educational frameworks.

6.2. Challenges to handle

Some overall challenges from the first implementation round were also identified and discussed between the involved partners, as well as how to address these in the next round. These challenges were identified into the following themes:

1. **New implementations take extra time** – enacting change in teaching practices is time-consuming, especially during the initial stages.
2. **Teacher attitudes** – some teachers do not see the COSMOS approach as an “add-in”, but rather as an “add-on” in the science curriculum. Hence, not integrated into the curriculum.
3. **Creating CoPs** – not enough time for this in some of the countries. Not knowing how and where to find contacts.
4. **The support from school leadership** – are the school leaders aware of the possible outcomes of the COSMOS approach and how can they in the best way support teachers?

In summary, the themes include challenges in the time-consuming nature of change, challenges in curriculum integration, the role of school leaders, changing attitudes, and how to develop practices of collaborative networks

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6.3. Recommendations for the next round

Based on the positive experiences from the first round of implementation as well as address challenges we have the following recommendations for the next round:

1. Keep on with the approach of teacher empowerment and decision-making.
2. Keep on finding a balance between school needs and project needs.
3. During TPD - be honest with teachers that new educational initivatives take extra time at least initially.
4. During TPD – emphasise the positive outcomes of working with the COSMOS approach, and share good practices and research findings, especially about students' learning in science when working with SSIBL to develop teacher attitudes. There's a need to address attitudes and encourage teachers to view the approach as an "add-in" to their teaching rather than an "add-on". It is important to try to shift teachers' perspectives and foster a mindset of integration.
5. Work more with school leaders who recognise additional positive outcomes of teaching beyond content knowledge. This may lead to more support for the teachers and promotion of the educational innovation through the COSMOS approach.
6. Partners should be more supportive in how CoPs can be established as well as involving external stakeholders in the co-design process.

Altogether, we consider the experiences from the first implementation round as positive and look forward to developing the work in the next round with the summarised experiences and recommendations as useful guidelines.

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Appendix

In this section you find tables showing overviews of the SSIBL-CoP implementations in each secondary school with each of the steps in SSIBL included.

Belgium school 1

SSIBL dimension	Description	Duration
ASK	**How do we improve the environment of the school?** The local police office clustered some of the main issues they face in the vicinity of school district. Students from the two participating classes explore the reported problems, go for a walk around the neighborhood and choose one topic. Class a will be working on homelessness issues. Class b reflects further on the increasing insecurity caused by the high speed of speedelecs. **Exploring chosen problem situation** Through different work forms offered by Djapo - e.g. kaas met gaten, probleemboom, terugdenken ... -, make your own thinking visible. The thinking tools help the students explore, compare and make choices about parts and wholes to focus on in the following steps of the project.	Lesson 1 (100min) Lesson 2 (100 min)
FIND OUT	**Preparation of the neighborhood investigation** Students consider: - What questions do we want to investigate? - In what ways can we obtain these answers? (interviews, surveys, talking to organisations,...) - Start drafting questionnaire with a clear goal in mind - Contact the organisations (by phone, via mail) **Implementation of the neighborhood investigation** - Interview with homeless people; - Interview with neighbors of the school; - Interview with homeless organization; - Interview with police and city custody; - Interview with passers-by in the parc. **Presentation of the results of the neighborhood investigation** Short, oral PowerPoint presentation about the results of the different neighborhood investigations - The viewpoint of the homeless people; - The viewpoint of the neighbors of the school; - The viewpoint of the homeless organisation; - The viewpoint of the police and city custody; - The viewpoint of the passers-by in the parc. **Working out a solution to their problem** This can be done using a text, prototype	Lesson 3 (100 min) Lesson 4 (100 min) Lesson 5 (100 min) Lesson 6 (100min)
ACT	**Presentation of the different solutions to the local police officer**	Lesson 7 (100 min)

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Belgium school 2

SSIBL dimension	Description	Duration
ASK	**1. Is tap water healthy? How can we, more responsibly, drink water?** The teacher introduced the topic by doing scientific demonstrations of experiments with different liquids and using an indicator to explore what water is. Afterwards, students watched a video about the benefits of tap water. **2. How can we reduce the consumption (and by doing so, the cost) of (bottled and tap) water?** Introduction by means of systems thinking and based on checked facts (Flemish state television): tap water vs bottled water. Information about tap water by Flemish consortium of tap water distributors. Documents about the information on a tap water bill and means to save water.	One quarter of a project day (day 1) One quarter of a project day (day 2)
FIND OUT	**1. Research activities** - Qualitative experiment: difference between tap water, bottled water and demineralized water (cfr. Evaporation) - Quantitative experiment: comparative study on presence of chlorine, nitrates and fluoride in tap water, bottled water and water of a river nearby the school - Poll, group discussion and group reflection: who drinks tap water and why (not)? - Tasting test: bottled water vs. tap water/can you taste the difference? **2. Research activities** - Mapping the water consumption in the school and at home - Locating and identifying the water meters - Reading and interpreting the water meter data - Calculating the tap water consumption and cost over a given period of time - Interpreting the tap water consumption	One half of a project day (day 1) One half of a project day (day 2)
ACT	**1. How can we motivate ourselves to drink more tap water (instead of bottled water)?** - Inspirational video about water mocktails - Group contest: making water mocktails **2. How can we reduce the tap water consumption in our school?** Formulating water-saving suggestions and addressing them to the school leaders: message in a bottle	One quarter of a project day (day 1) One quarter of a project day (day 2)
Evaluation/ reflection	**General: individual reflection (online form)** - What did you like about project day 1/2? - What did you dislike about project day 1/2? - How would you describe project day 1/2? - What will you certainly remember about the two project days? (open question)	After the project

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England school 1

SSIBL dimension	Description	Duration
ASK	**SSI question: What should we do about waste management at our school?** Students 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. This was set as an online homework task. The student 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. 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, 27th Feb 23) Lesson 1 (50min approx., 20th March)
FIND OUT	Students 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). Students 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. Students 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., 20th March) SSIBL Science day (5 hours)
ACT	**Voting:** At the end of the SSIBL Science Day, students 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 groups of the top three posters then presented their solutions to the school's senior leadership team, and other CoP members and community stakeholders.	SSIBL Science day (5 hours) SSIBL Science day (5 hours) Presentation to CoP about solutions identified (50min approx.., 14th June 2023)

Israel school 1

SSIBL dimension	Description	Duration
ASK	What is the importance of maintaining the Gazelle Valley as an urban nature reserve? The question was proposed by the principal in advance and was not changed throughout the implementation process.	

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FIND OUT	Understanding the environmental and social aspects and interconnections of the Gazelle Valley nature reserve in homeroom classes prior to the peak-day. Peak-day activities included learning and investigation stations focusing on different aspects of the ecosystem, including creative activity stations: - Distinction between biotic and abiotic factors - Measurement of abiotic factors - The food web. - Detection of producers (plants) in the Valley - Exploration of the terrain - Photography workshop - Creativity stations (artwork)	1 lesson Whole day (6 hours)
ACT	No real ACT activities tool place. Possibility for responsible ways of acting came up in the discussion conducted in the stations, but these were not translated into actions conducted by the students.	

The Netherlands school 1

SSIBL dimension	Description	Duration
ASK	**Fossil fuel cars and scooters should be banned from the city** The teacher introduced the statement on a slide and asked students to take a position in the classroom based on their initial opinion, and whether this opinion was more rationally backed-up or more based on their feelings/ emotions about the statement: activity 'arguments in motion' The teacher asked some students why they were standing at that position, responses e.g., '*we are not ready for a change yet', 'not everyone can afford an electric car or scooter' , 'they pollute the air'* So students expressed their initial opinion and heard (and saw) what their peers opinion was and why (personal inquiry). The teacher summarised some arguments and indicated that one important aspect of air pollution is particulate matter.	Lesson 1 (~15 min.)
FIND OUT	The teacher showed a slide on particulate matter (e.g., tiny particles in air 10< 1 um, affect your health, natural and human sources, different types) and posed the question: *what sources can you think of*? The class was divided in 6 groups and filled in a worksheet with questions such as: - Who would be in favour of the statement and why? - Who would be against the statement and why? - Possible solutions As such making a start with societal inquiry As start of the scientific inquiry, the teacher explains the working of the particulate matter sensors. Every group gets a sensor and should do measurements in the city/ environment this week. Worksheet 2: Student groups need to think of/ formulate a research question or hypothesis they want to inquiry with help/ data gathering with the particulate matter sensor that can be attached to their bike. They need to plan who is doing the measurements in the upcoming 4 days (outside school hours).	Lesson 1 (~15 min.) Lesson 1 (~40 min.)

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	The sensors are provided (lent out) by Globe Netherlands in collaboration with RIVM (National Institute for Health and Environment) https://globenederland.nl/docenten/18-globe-scholen-meten-fijnstof-met-snuffelfiets/ Data students collected with the sensors are stored (automatically) in an online data system of the national RIVM	Particulate matter measurements by student groups outside school hours
FIND OUT	Teacher introduced Globe and showed promo clip of Globe on 'Air quality' – linked it to the regular curriculum (Chapter 7, chemistry textbook on 'Combustion fuels' as one part of particulate matter) Teacher shows video about particulate matter effects on healt ; and video on crude oil Practical: students have to build different molecules with the molecule building blocks as part of their formal curriculum (Chapter 7) → e.g. find out how many possibilities there are for C4H10 and C5H12 (isomers)	Lesson 2 (~20 min.) Lesson 2 (~15 min.) Lesson 2 (~35 min.)
ACT	The ACT part is not implemented in the lesson by the teacher. The teacher indicates that the student groups should make a poster today. He provided them with a description of what should be on the poster. 'Same steps as you see in a report should be on the poster: (introduction, hypothesis, method, results, conclusion, discussion)'. There is a rubric that will be used to grade the posters. Students are given the rubric ahead of time so they know what to look for. Students get to work on making a poster, they are given a worksheet (worksheet 3) for this purpose. Students can access their data online since the data they collected with the sensors are stored (automatically) in an online data system of the national RIVM. The poster does not refer to the first lesson, students reflect on the conduct of the investigation, not on the SSI or the form of work covered in the first lesson.	Lesson 3 (~90 min.)

Portugal school 1

SSIBL dimension	Description	Duration
ASK	**How to live in a planet that shakes? Are we ready for an earthquake?** Both the teachers (7th grade Natural Sciences and 8th grade Chemistry and Physics) based all the activities in the worries (and all the questions) of the students about a possible earthquake happening in Portugal and the readiness level of the country for such an event. Students' questions and worries were motivated by the earthquake (with severe consequences) that had just happen on that time in Turkey and Syria. And Portugal is a place with high seismic activity.	Task 1 (1h approx.)
FIND OUT	In both classes (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 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 the Natural Sciences class (7th grade), students were inquiring (using books, Internet and videos) about the causes of the earthquakes (plate tectonics) and the internal	Task 2 (1h approx.)

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	structure of the planet Earth and building models of the internal structure of the planet Earth. In this phase, they 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 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, they 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 next task, in the Natural Sciences class (7th grade), students inquired about possible ways to avoid big catastrophes as a consequence of 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. 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. Then, in the Chemistry and Physics class (8th grade), they built (in groups) videos on how to prevent fires and how to behave during a fire in school or at home. and one parent with knowledge of Mandarin). In the Natural Sciences class (7th grade), different 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. 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 as a consequence of an earthquake. These works were also presented and discussed in the class. Then, in the Natural Sciences class (7th grade), 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).	Task 3 - Natural Sciences class 7th grade (2 hours approx.) Task 3 - Chemistry and Physics class 8th grade (2 hours approx.) Task 4 - Natural Sciences class 7th grade (3 hours approx.) Task 4 - Chemistry and Physics class 8th grade (3 hours approx.) Task 5 - Chemistry and Physics class 8th grade (2 hours approx.) Task 5 - Natural Sciences class 7th grade (6 hours approx.)
ACT	To increase the action component of the COSMOS project, some of the activities proposed at Natural Sciences class (7th grade), were planned in order to involve the students' families in their development (e. g. the self-protection emergency kits). This way, the formative component reached their families. 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	Task 6 - Natural Sciences class 7th grade

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	school. In this task, they had the help of the teacher of Portuguese Language. During this 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). The videos prepared in the Natural Sciences class (7th grade), with their different learnings about earthquakes and how to behave during such an event, were published in the social media of the school in order to be spread to the entire community. 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). The videos prepared in the Chemistry and Physics class (8th grade), with what they considered as their most important learnings – about how to prevent a fire and how to behave in the case of a fire at school or at home – were published in the social media of the school in order to be spread to the entire community.	Task 6 - Chemistry and Physics class 8th grade (4 hours approx.) Task 7 - Natural Sciences class 7th grade Task 7 - Chemistry and Physics class 8th grade

Sweden school 1

SSIBL dimension	Description	Duration
ASK	Are GMO something good or bad?	Introduction lesson with students 40 minutes.
FIND OUT	- Basics about DNA and genes. - Examples of GMO – discussions - Tour to Alma Löv museum working with art-based inquiry and art related to GMO. Both discussions about already existing art at the museum and art-work creation activity together in small groups. - Art work creations at school related to GMO	Three lessons à 40 minutes One lesson à 40 minutes Whole day (á 6 hours) Whole day (á 6 hours)
ACT	Final discussions in class with arguments pro and con GMO. Plan for exhibition at the library in the municipality to be conducted after summer holiday.	One lesson à 40 minutes

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