CONNECT

Inclusive open schooling with engaging and future-oriented science

D4.2

Twelve sets of SCIENCE ACTION resources for formal education

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www.connect-science.net

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CONNECT

Inclusive open schooling with engaging and future-oriented science

D4.2

Twelve sets of SCIENCE ACTION resources for formal education

DELIVERABLE TYPE

Websites, patents filing, etc.

MONTH AND DATE OF

February 2022

WORK PACKAGE

WP4

LEADER

Mastery Science

DISSEMINATION LEVEL

Public

AUTHORS

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Programme	Contract	Duration	Start
H2020	872814	36 Months	September 2020

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Revision History

VERSION	DATE	REVIEWER	MODIFICATIONS
0.1	09/01/2022	Dr Tony Sherborne	1st Draft Structured Scenarios
0.2	20/01/2022	Dr Alexandra Okada	2nd draft CARE, KNOW, DO framework and RRI approach for developing Resources
0.3	31/01/2022	Partners' contributions in the platform	structured scenarios feedback and peer-review
0.5	20/02/2022	Peer-Reviewers (all partners)	Peer review
0.6	25/02/2022	Dr Tony Sherborne Dr Ale Okada	Final version incorporating reviewers' comments
1.0	28/02/2022	George	Quality check and final version submitted

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Index of Contents

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Executive Summary

This document presents a summary of CONNECT Open schooling resources available in the platform. This document outlines the sets of SCIENCE ACTION resources implemented in phase 1 by seven partners: structured scenario materials linked to science curriculum in school (formal learning) and open scenario with participatory science tools outside school (informal learning).

In addition, this document provides a new set of guidelines for producing a shorter version of resources focussed on CARE-DO framework to increase the adoption of open schooling. Our aim is to provide flexibility with clear guidance for participants who will be creating, readapting and reusing resources to promote CONNECT open schooling model in phase 2 scalability and phase 3 sustainability.

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1. Introduction

The CONNECT project is underpinned by the Responsible Research and Innovation (RRI) approach, for aligning scientific research with societal needs, concerns and expectations (EC, 2020). The materials that CONNECT produces give special attention to the RRI dimensions: of gender, ethics, public engagement and governance (see Fig.1).

The purpose of WP4 is to produce 'Customizable project resources that support' to enable teachers, students, STEM professionals and parents to successfully implement 'Science actions'. This is a new kind of open educational resources: a set of activities to integrate a real-life challenge into an existing topic

WP4 builds on the engagement toolkit from WP2 and develops curriculum materials for each of the CARE-KNOW-DO stages in our curriculum model.

We will use a 'backwards design' approach, starting with the objectives for each stage, and using research-based pedagogies and participatory design, to ensure that materials are high quality, easy to use, inclusive, and work well in a wide variety of classrooms.

The materials include: stimulus materials for engaging students for the STEM professional, awareness-raising activities for families, (CARE), teacher guides on how to integrate with the teaching of a science concept (KNOW), plus activities and student sheets for students to produce the output, and guidance for STEM professional on evaluating student work (DO). The materials vary in length and sophistication, to allow teachers flexibility of use.

2. CARE-KNOW-DO Science action

2.1 Structured and Open-ended scenarios

CONNECT is producing two kinds of Science-actions: Structured scenarios and open-ended scenarios.

a) Structured scenarios come with pre-researched issues and fully developed activities that schools can easily adopt or customize to maximize the chance of a successful first-time project.

The activities are designed to integrate a real-life challenge into an existing topic. It ticks lots of boxes:

√ Applies a science concept

√ Teaches an enquiry skill

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√ Provides an authentic end of unit assessment
√ Shows students how science affects their world
√ Gets students interacting with a scientist or engineer (supplied by the project)
√ talking about science with their family

b) Open-ended scenarios provide only a template structure for schools and science professionals to develop their own issues and activities.

2.2 Key features of a Science action

The Science actions all share a number of key features to achieve the project's objectives, and make the resources useful for schools:

- Students address a real-world problem
- Students interact with STEM professionals
- Students interact with families
- Follows the structure: CARE-KNOW-DO

2.3 Different types of structured scenarios

CONNECT produced 14 structured scenarios for schools, which are being tested and refined:

Microplastics, Energy savers, Rewilding, Poo transplants, Carbon Neutral COP26, Handwashing, Transmission , Ventilation, Aerosol, Creating and Using Maps for Problem Solving, Biodegradable plastics, Plastic and food, Polymer Plastic and, Renewable Energy.

These are described in more detail in section 4.

Some of the Science actions are longer and more sophisticated. Others are shorted and easier to use, especially for time-pressed teachers. The diagram (Figure 1) describes the differences between the two types.

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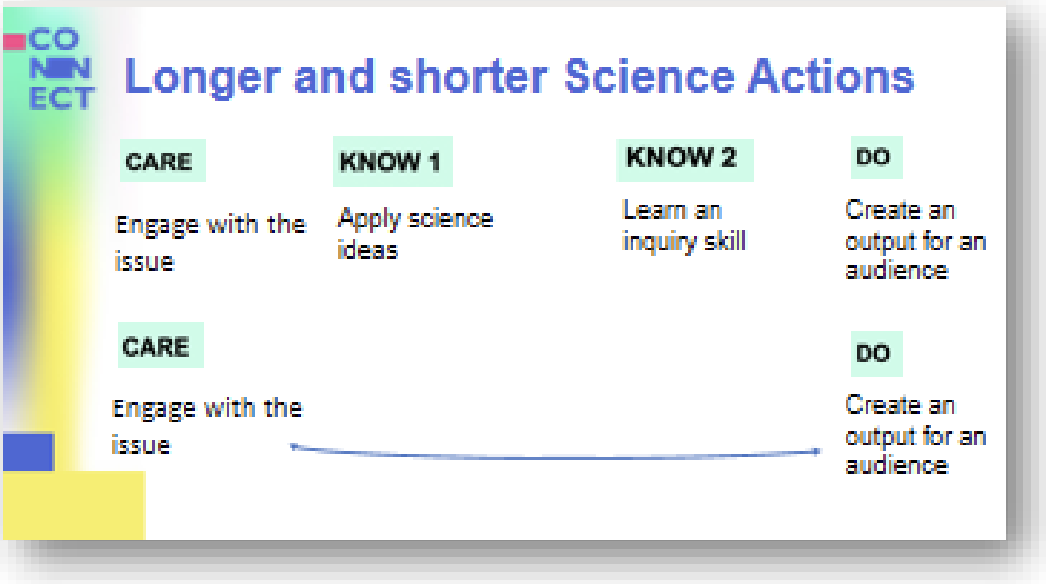

Figure 1- Guidelines for teachers explaining long and short science actions

Longer Science actions are expected to take up to 4 hour-long lessons in the school plus up to two hours at home activities. Some teachers may be reluctant to use them because of lack of time in the curriculum, which is a particularly challenge in science where the amount of content to cover can be overwhelming.

This is the rational for designing shorter Science actions. These are expected to take around half the time, that means 2 hour-long lessons at school and 1 hour at home activities. They can also be used to increase student engagement post-Covid, without taking up too much time. They also serve as an introduction to the strategies of CONNECT, before making a commitment to use longer Science actions in the future.

2.4 CARE-KNOW-DO Model

CONNECT uses a 3-stage model (Figure 2) to integrate a real-life challenge with an existing science topic:

CARE: Includes 'motivation to learn' at the start, through the setting of a challenge. The first, largely informal learning stage is designed to introduce the future-orientated issue, stimulate questions, and create a 'need to know' that teachers can harness in the next stage.

KNOW: Activities after each concept is taught. The second learning stage is focused on students acquiring the scientific understanding and skills they need to make decisions and take actions in the final stage. It is mostly a formal

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learning stage, but can be enhanced with inputs from families and the STEM professional.

DO: Provides evidence of learning. In the final stage, students collaborate to complete the challenge. They design and present an output for an audience, which is assessed. It can include tasks to do at home using inputs from families.

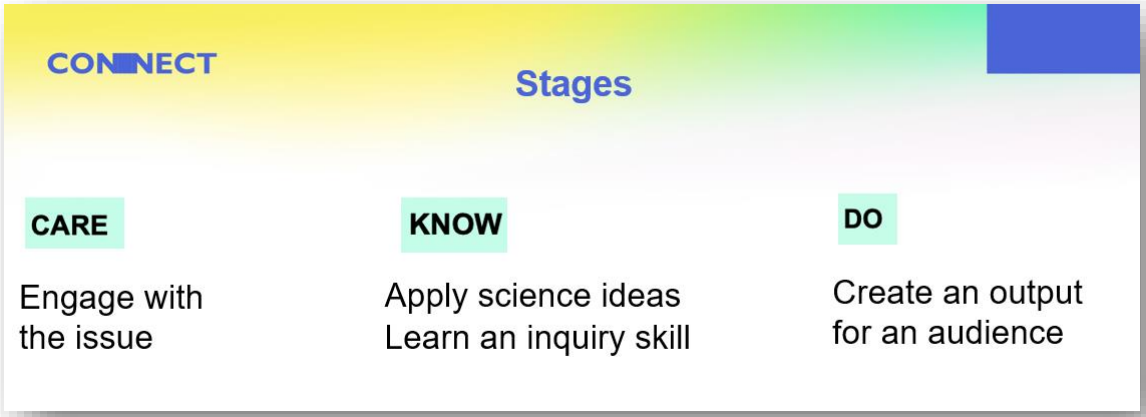

Figure 2- CARE-KNOW-DO model

Example:

Rewilding integrates with the Year 7 unit: interdependence. In the Blueprint 5-year plan there are 3 Key Concepts (Feeding relationships, Competition, Abiotic & biotic). Here's how it fits into the unit:

CARE	Teach	KNOW 1	Teach	KNOW 2	DO
Challenge	Feeding relationships Competition	Wolves	Abiotic & biotic	Beavers	Campaign

Yellow boxes = existing lessons. Green boxes = Rewilding activities.

3. Structured Scenarios

In this section we describe the process for developing and publishing.

3.1 Design criteria for socio-scientific issues

Selecting appropriate issues is important because they have to meet many criteria, to achieve the project goals, and also to meet the needs of

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teachers and students. For this, we developed a set of criteria which the team uses to filter ideas and select the most promising issues:

Design criteria

i. A balance of personal, community and global issues with local relevance for Youth.
ii. Appeal for girls and boys, based on research ('Relevance of Science Education' project (Sjøberg et al.,2010) and consultation with students including special attention for disadvantaged and disaffected students.
iii. Desirable future scenarios identified by European citizens in other projects like CIMULACT, or fits into one or more of the UN sustainable development goals.
iv. Fits an area of the science curriculum.
v. Possible to localise for different countries.

Example:

The issue in Rewilding (Figure 3) is about whether we should reintroduce extinct animals into an ecosystem. It is a real-life issue, sometimes controversial, which is currently happening across the world.

- Issues involving animals are of interest to both boys and girls aged 11-14.
- It fits the sustainable goals: 14 Life below water and 15: Life on land.
- It fits into the curriculum area of interdependence.

So, the Rewilding issue meets the design criteria, and was selected for development.

Figure 3- Rewilding open schooling material for students

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3.2 Design criteria for Care-Know-Do stages

To ensure high quality materials that meet teachers and students' needs, the team created a set of design criteria to be used as a 'touchstone' throughout the development process. We describe these for each stage, with an example.

3.2.1 Care stage

The CARE stage is in two parts: i) In school – introduction, and ii) At home - family activity

In school

The Science action begins with the teacher introducing the issue to, students and setting the 'challenge' - the decision or judgement that students will come to by the end.

The design criteria of learning activities at school contains four components: engaging, emotive, simple and challenging (Figure 4).

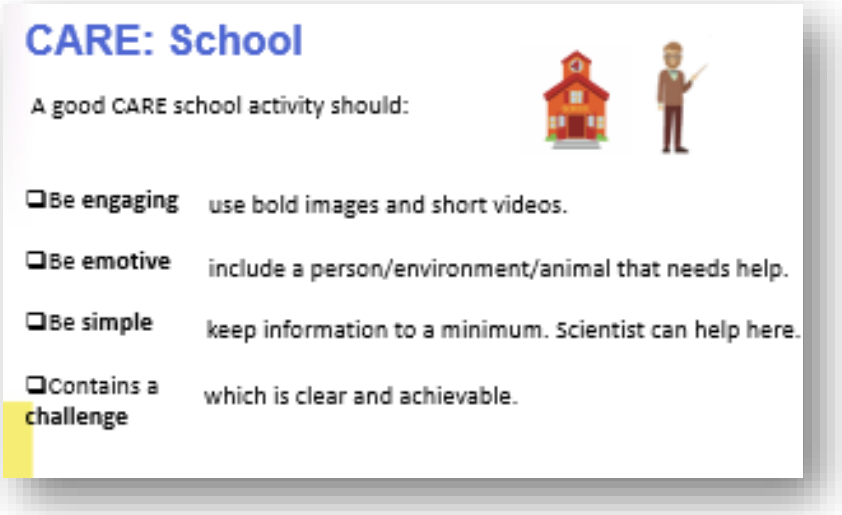

Figure 4- Open Schooling material – design criteria for CARE stage at school

Example: Carbon neutral (Figure 5) begins by introducing the indeed to reduce carbon emissions. Then students are set the challenge of helping a cafe become carbon neutral.

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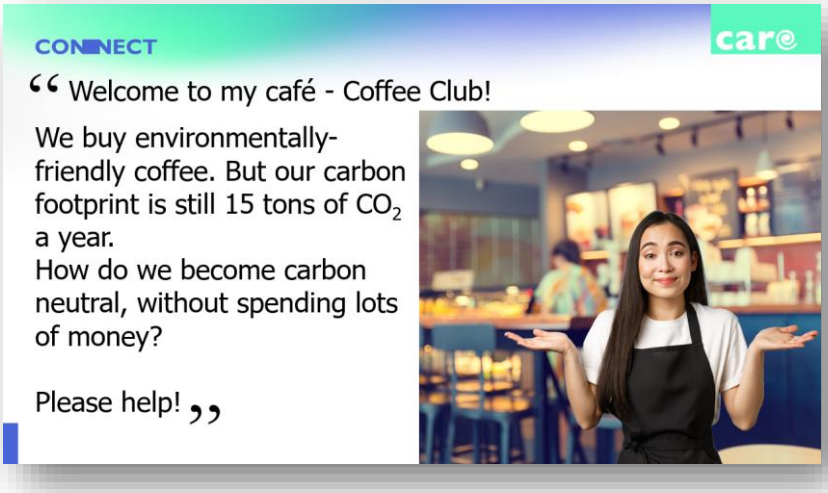

Figure 5- Carbon Neutral - open schooling material for students - CARE stage at school

At home

After the introduction, students will find out more about the challenge at home, together with their family. The home activity (Figure 6) includes three steps:

1. A simple introduction to the issue
2. An engaging task that begins to work on the challenge, and promotes collaboration and discussion
3. Ideas for further exploration e.g. links to information and videos.

The design criteria of learning activities at home contains four components: fun, achievable, collaborative and CONNECTed to the curriculum outcome.

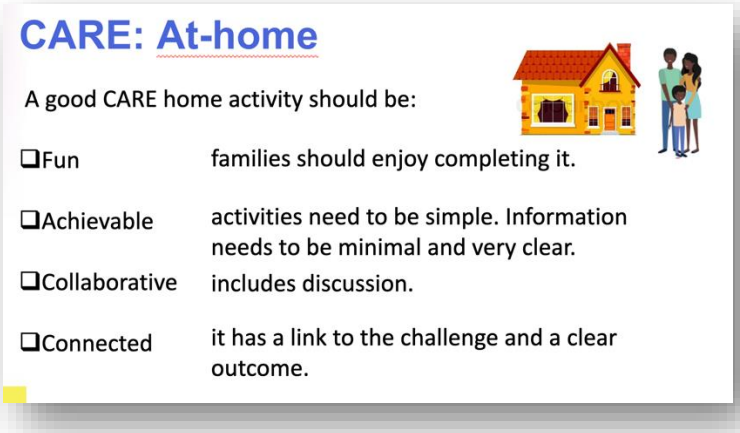

Figure 6- Open Schooling material – design criteria for CARE stage at home

Example: In Poo transplants, the challenge to advise a friend on whether a faecal transplant will help with his obesity. The home activity (Figure 7) gets students to find out how gut bacteria are important for health.

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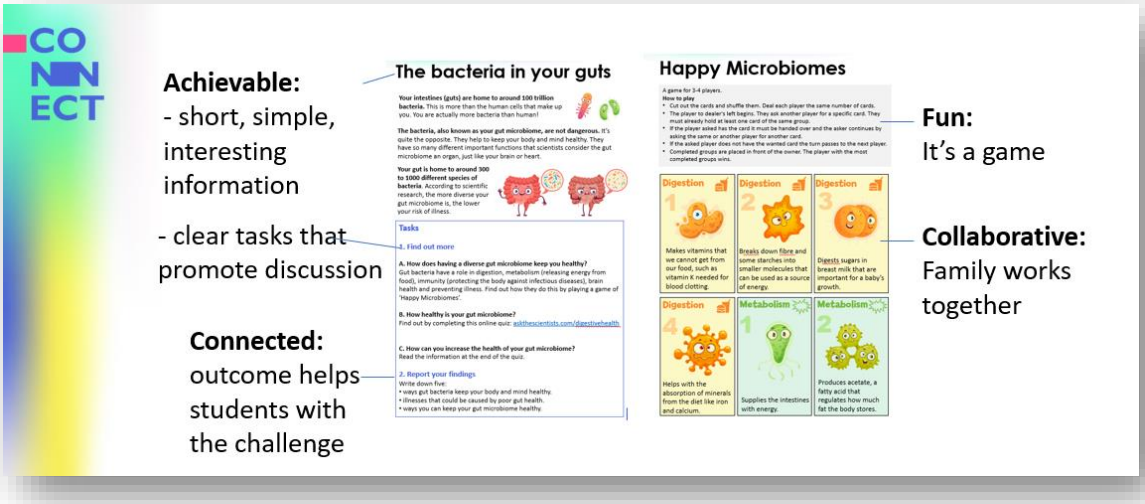

Figure 7- Open Schooling material – open schooling material for students - CARE stage at home

3.2.2 Know stage

'Know' means activities that build on the science students have been taught and apply the knowledge to the issue. The activities also justify added time by teaching enquiry skills too.

The design criteria of learning activities at school contains four components: developing knowledge and skills, easy-to-follow tasks, scientists interaction, and support to solve the challenge (Figure 8).

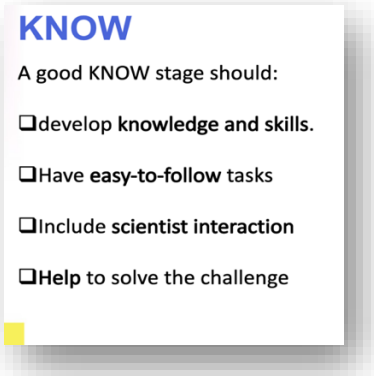

Figure 8- Open Schooling material – design criteria for KNOW stage at school

Example:

In 'Handwashing', (Figure 9) students are set the challenge of persuading others that washing hands regularly can reduce the spread of infectious disease. The 'Know' activity applies knowledge of how infectious diseases are transmitted, by getting students to compare the number of bacteria on washed and unwashed hands with an experiment. Students apply science learned to start responding to issue.

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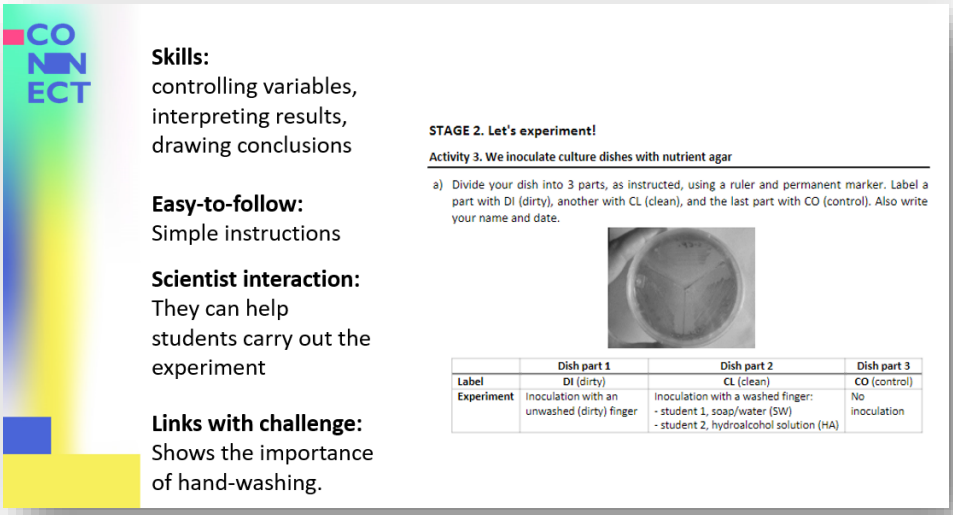

Figure 9- Open Schooling material – open schooling material for students - KNOW stage at school

3.3.3 Do stage:

In the final, 'DO' stage students use what they have learnt to complete the challenge. Do involves producing a creative output, something they students can take pride in, and which can be presented to give external validation by an external audience.

The design criteria of learning activities at school contains four components: output for the challenge, students use learning, collaboration and presenting, and assessment advice (Figure 10).

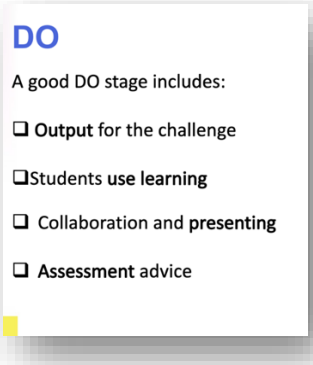

Figure 10- Open Schooling material – design criteria for Do stage

Example: In Rewilding (Figure 11), students create their campaign. They work in a group to create a presentation and persuade an audience that their animal should be rewilded.

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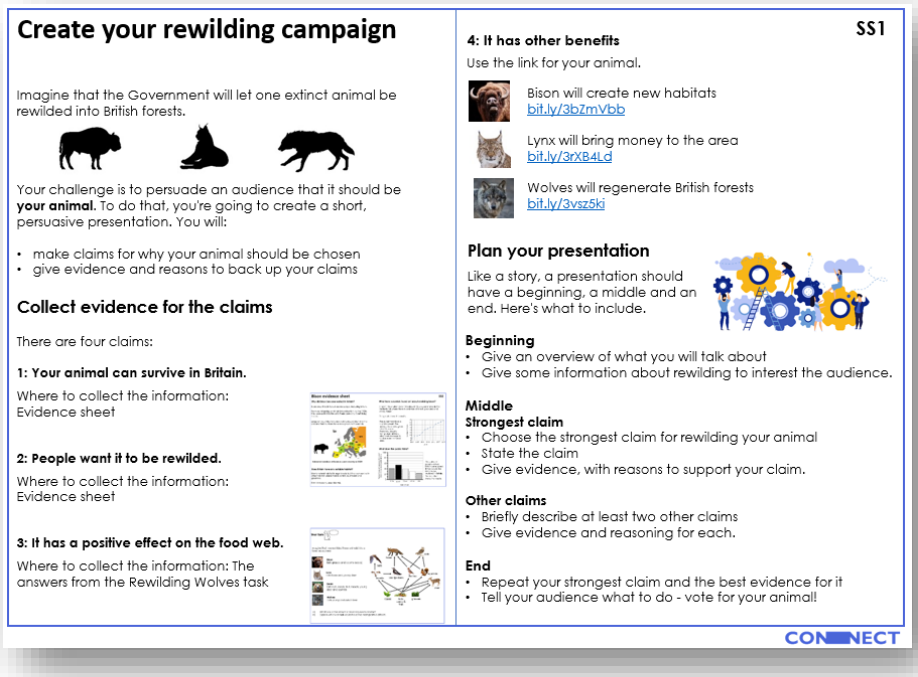

Figure 11- Open Schooling material – open schooling material for students – DO stage

3.3 The development process

There are several stages in a rigorous curriculum development process. It starts with a broad overview, and then follows a cycle of development-review-iteration to make more specific decisions until all the activities and resources are mapped out in detail. This section describes the stages.

i. **Ideas -** the team comes up with a variety of possible issues CONNECTed with a science curriculum topic. We look at topical news stories, sustainable development goals, and areas of interest for students. Then the team evaluates each possible idea against the criteria to choose an issue that will 'work'.

ii. **Outline -** the team works out the key features of the planned Science action
   - how the issue matches to a specific science curriculum topic in one grade
   - what students will do for each activity (CARE home, KNOW 1, KNOW 2, DO).
   - how the outcomes of each stage will be assessed.

iii. **Outline review -** The team seeks feedback on the feasibility of each stage from reviewers. The reviewers Include people with understanding of the realities of science teaching and learning, and people who have not been involved in the writing,

iv. **Draft -** the team write all teacher and student materials including images and diagrams.

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v. **Draft review -** This is a final quality check from other members of the consortium on what changes would have to be made to match their science curriculum, how well each stage (CARE, KNOW, DO) matches the criteria, how suitable the activities are for the age group of the students.

vi. **Translation and localisation** - This is by consortium partners so that the curriculum references, contexts, cultural references and examples, and activities and language are suitable for use in their country.

3.4 Publication of materials

The materials are published on the CONNECT platform. Since they have to compete for attention with all the other resources that teachers can access, the way they are presented is important.

We developed a set of 4 questions that teachers might ask when visiting CONNECT

- Q1: Is there something on what I'm teaching?
- Q2: Will it cover the curriculum objectives?
- Q3: Will my students be engaged and learn?
- Q4: Is it easy to figure out and use?

We then answered these questions to determine how best to present the materials online. These features have been implemented on the CONNECT platform

- Q1: Is there something on what I'm teaching?
  - Browse by curriculum topic/stage
  - Search by tag
- Q2: Will it cover the curriculum objectives?
  - Clearly described learning objectives
  - Use curriculum references
- Q3: Will my students be engaged and learn?
  - Engaging description
  - Show a sample
- Q4: Is it easy to figure out and use?
  - Well-structured teacher guide
  - Clearly titled & described materials

In addition, the team wants to know teachers' feedback, to make any changes needed, and to encourage other teachers to use the Science actions. So we asked and answered an additional question, which led to a need for a comments section on each page

How do we get teachers give feedback?

- Make it easy

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- Populate with pilot reviews

4. Published materials

The example about Carbon Neutral COP26 illustrates the description of a structured material in the platform, which contains ten elements: real-problem, future-oriented science action, sustainable development goas, curriculum links, structured material content, CARE-KNOW-DO activities, fun participatory science, competence-based assessment, references and, CONNECT files for download.

Title: Carbon Neutral COP 26

1.REAL-PROBLEM

Carbon neutrality is a state of net-zero carbon dioxide emissions. This can be achieved by eliminating emissions and balancing emissions of carbon dioxide with its removal (carbon offsetting). Carbon-emitting processes are associated with transportation, energy production, agriculture, and industry. The world is running out of time to protect the planet from the worst effects of climate change. Many see the COP26 meeting, which was held in the UK in November 2021 as the world's best last chance to get climate change under control. Here world leaders will agree to measures to reduce carbon emissions. Everyone must play their part: individuals, households and businesses.

2.FUTURE-ORIENTED SCIENCE ACTION

The Carbon neutral science-action prepares students to plan a presentation to win the job of being a café's carbon consultants and help them achieve carbon neutrality. Students use their knowledge of the Earth's atmosphere and the inquiry skill of considering different perspectives.

3. SUSTAINABLE DEVELOPMENT GOALS

SDG07. Affordable and clean energy

SDG13. Climate action1

SDG02. Responsible consumption and production

4.CURRICULUM LINKS

Knowledge: Chemistry – Earth's atmosphere – climate change

Skills: Consider different perspectives and communicate ideas

Attitude & Values: environmental protection, work in teams

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Lesson KNOW 1

Concept: Earth's atmosphere

Learning stage: Apply

Lesson KNOW 2

Concept: Global warming

Skill: Consider different perspectives

Learning stage: Analyse

5.STRUCTURED MATERIAL CONTENT

- Teachers guide
- Information for STEM professionals
- Teaching PowerPoint presentations
- Home task
- Student sheets and assessment rubric

6.CARE-KNOW-DO ACTIVITIES

There are 4 activities which can be fitted around existing science lessons.

You can take part in any of these activities designed with four learning objectives:

1. Understand the scientific context (CARE).
2. Apply earth's atmosphere/carbon cycle to a new context (KNOW 1).
3. Practice the skill 'Consider different perspectives (KNOW 2).
4. Coordinate scientific knowledge and skill in a performance assessment (DO).

7.FUN PARTICIPATORY SCIENCE

This science action engages students, family members, science professionals (Climate scientists, environmental chemists, chemical engineers).

Students are invited to identify issues and co–create solutions, interact with experts, and become activists for environmental protection.

8.COMPETENCE-BASED ASSESSMENT

1. Students feedback about their views of science, including engagement, confidence, and identity.
2. Students and teachers templates to assess knowledge and skills.
3. Students feedback about their science capital in the context of open schooling.

9.REFERENCES

Youtube: Can YOU fix climate change?

10.CONNECT FILES FOR DOWNLOAD

01-Carbon-neutral-Teacher-Guide Download

02-Carbon-neutral-Information-for-STEM-professionals Download

03-LESSON-Carbon-neutral-CARE Download

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04-HOME-Carbon-neutral-CARE Download

05-LESSON-Carbon-neutral-KNOW-1 Download

06-LESSON-Carbon-neutral-KNOW-2 Download

07-STUDENT-SHEETS-Carbon-neutra l Download

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The following table 1 shows the 14 Science action resources developed and being published by all the partners, that means 11 long resources and 3 short resources.

Table 1 CONNECT – structured curriculum materials.

Name	Length	Summary	Science topic	Link
Microplastics	short	Students learn about the size and scale of small particles. They act as teenage activists to convince people how they can best reduce their contribution to microplastic pollution and why they should.	Particle model Mixtures	https://CONNECT-eu.exus.co.uk/2022/02/23/microplastics/
Energy savers	Short	Students create a crowd-funding campaign to help an entrepreneur fund the development of a new energy saving device.	Energy transfer Wasted energy	https://CONNECT-eu.exus.co.uk/2022/02/23/energy-savers/
Rewilding	Long	Students create a campaign to convince the public	Food webs Competition	https://CONNECT-eu.exus.co.uk/2021/08/05/rewilding-europe/

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		that an extinct animal should be rewilded.	Abiotic & biotic factors	https://CONNECT-eu.exus.co.uk/2021/09/30/επανεισαγωγή-ζώων-στην-ελλάδα/ https://CONNECT-eu.exus.co.uk/2021/09/23/refaunacao-pantanal/ https://CONNECT-eu.exus.co.uk/2021/09/23/renaturalizarea/
Poo transplants	Short	Students advise a family friend about whether a faecal transplant can help cure obesity.	Digestion	https://CONNECT-eu.exus.co.uk/2022/02/23/poo-transplants/
Carbon Neutral COP26	Long	Students help a café to become carbon neutral by reducing carbon emissions and offsetting.	Climate change	https://CONNECT-eu.exus.co.uk/2022/01/31/carbon-neutral-cop26/ https://CONNECT-eu.exus.co.uk/2022/02/08/μηδενικό-ισοζύγιο-άνθρακα/ https://CONNECT-eu.exus.co.uk/2022/01/11/carbon-neutru/
Handwashing	Long	Students take part in experimental work to visualize microorganisms and to raise awareness that contagion can be prevented through handwashing. They take part in a school-wide competition to	Infectious disease	https://CONNECT-eu.exus.co.uk/2021/11/25/**handwashing/** https://CONNECT-eu.exus.co.uk/2021/11/25/**lavado-de-manos/** https://CONNECT-eu.exus.co.uk/2021/11/25/**rentat-de-mans/**

		design a poster for World Hand Hygiene Day.		
Transmission	Long	Students carry out an experiment that simulates contagion in a community and how mask wearing affects transmission. They design and develop an activity aimed at communicating the importance of masks to reduce infection.	Infectious disease	https://CONNECT-eu.exus.co.uk/2021/11/26/**transmission/** https://CONNECT-eu.exus.co.uk/2021/11/26/**transmisibilidad** https://CONNECT-eu.exus.co.uk/2021/11/26/**transmissibilitat/**
Ventilation	Long	Students apply the knowledge acquired about methods of transmission and develop a final product that responds to the problem by proposing recommendations for improving the current	Infectious disease	https://CONNECT-eu.exus.co.uk/2021/12/02/**ventilation/** https://CONNECT-eu.exus.co.uk/2021/12/02/**ventilacion/** https://CONNECT-eu.exus.co.uk/2021/12/02/**ventilacio/**

		school ventilation protocol.		
Aerosols	Long	Students evaluate the feasibility of using carbon dioxide sensors to monitor the risk of covid transmission inside buildings.	Infectious disease	https://CONNECT-eu.exus.co.uk/2022/02/23/aerosols/ https://CONNECT-eu.exus.co.uk/2021/11/05/αερολύματα/
Creating and Using Maps for Problem Solving	Long	Students use mapping skills to solve a spatial problem that they face in their daily life.	Science in Society	https://CONNECT-eu.exus.co.uk/2022/02/23/maps/
Biodegradable plastics	Long	Plan and carry out a campaign to convince the public and the authorities that the conditions/framework should be provided for the gradual introduction of products based on biodegradable plastics.	Chemical compounds, Environmental protection	https://CONNECT-eu.exus.co.uk/2022/02/22/bioplastic-en/ https://CONNECT-eu.exus.co.uk/2022/02/17/bioplastic-ro/

Plastics and Food	Long	Students discuss the use of plastics in the food packaging industry, widespread as polymeric plastic packaging has a number of advantages such as easy handling, moldability, increased corrosion resistance, resistance to moisture and solvents, low cost, lower weight compared to metal and glass etc.	Environment	https://CONNECT-eu.exus.co.uk/2021/11/05/πλαστικα-και-τροφιμα/
Polymer Plastics	Long	Students investigate the ever-increasing demand for plastics which has caused problems with the disposal of their waste. Plastic waste causes serious environmental	Environment	https://CONNECT-eu.exus.co.uk/2021/09/28/πολυμερή-πλαστικά/

		problems as almost a third of all plastic packaging leaks into the sea.		
Renewable Energy	Long	Students explore Power plants that use lignite as a raw material causing air pollution and are dangerous to human health. Also, the effects of burning mineral resources such as lignite are associated with the problem of climate change and global warming. The solution to this problem can be provided by renewable energy sources which come from natural processes and do not burden the environment.	Energy	https://CONNECT-eu.exus.co.uk/2021/09/27/ανανεωσιμεσ-πηγεσ-ενεργειασ/

EXUS
Greece
www.exus.co.uk

OU
Uk
www.open.ac.uk

DBT
Denmark
www.tekno.dk

IRSICAIXA
Spain
www.irsicaixa.es/en/livinglabhealth

MSc
Uk
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www.valahia.ro

LOBA
Portugal
www.loba.pt

UNEB
Brazil
www.portal.uneb.br

PUCPR
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