CONNECT

Inclusive open schooling with engaging and future-oriented science

Deliverable 2.1

Catalogue of Inspiring Resources

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Catalogue of Inspiring Resources

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AUTHORS

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Revision History

VERSION	DATE	REVIEWER	MODIFICATIONS
0.1	28/12/2020	Alexandra Okada	Suggestion to add a section with conclusions and description of methodologies and pedagogical approaches in section 1.
0.2	30/12/2020	Alexandra Okada	Suggestion to add an executive summary and to edit some resources.
0.3	31/12/2020	Giorgos Panselinas	Suggestion to add an extra project.
1.0	31/12/2020	Eva Jaho	Quality check and final version submitted

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Executive Summary

This catalogue is aimed to inspire the CONNECT partners and other stakeholders by open schooling and stakeholders' engagement approaches that can be implemented in the design of educational materials, such as those that will be developed for creating 'Science Actions' and 'Open-ended scenarios' within CONNECT.

The 32 inspiring resources included in this catalogue exemplify some of these approaches to innovate in STEAM education with open schooling resources. Those resources have been selected according to a set of inclusion criteria described in Table 1. For each selection criteria we include examples of methodologies and pedagogical approaches and some key examples of projects and practices, i.e. lesson plans, activities, interventions and networks that fulfil these criteria.

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1. Introduction

1.1. Background

Science education plays a vital role in equipping young people to succeed and pursue science careers (Ryan, 2015). Economic projections indicate the need for one million more STEM professionals over the next decade (Labour Statistic, 2015), while 20.6% of pupils in Europe do not achieve basic proficiency (EC, 2017). Many students who could aspire to follow science-based careers do not pursue them, because they have 'low science capital' (Archer, 2014). They may find science interesting, but they do not consider themselves as future scientists because they lack cultural familiarity with science, confidence, role models or the opportunity to talk about and participate in science outside formal education (Riley, 2006). There is evidence that young people with higher science capital are more likely to aspire to continue with science.

A possible solution to increase these students' aspirations in science is to make school more open and establish ongoing external partnerships – through '**open schooling'** (Ryan, 2015; Okada & Sherborne 2018; Okada 2019), with STEM professionals and families. Doing projects with university researchers or industry professionals can provide more authentic contexts for students to learn skills and use knowledge. Such approaches do exist already; however, they are only used by a minority of schools and they tend to be marginalised. Schools adopt them either as extra-curricular activities or as activities focusing only on the more able or 'gifted and talented' students.

The CONNECT project is introducing this novel form of science teaching into school curricula in five countries: UK, Greece, Brazil, Spain and Romania. This innovation is based on the concept of **'science-action'**: a problem-solving activity where students learn science knowledge, skills and attitudes to tackle a future-oriented socio-scientific issue. Students then apply them by implementing actions in collaboration with scientists, families and other stakeholders to benefit their lives, their community and society. The project also promotes the so called '**Open ended scenarios**', where students also tackle socio-scientific issues in collaboration with different societal actors with participatory research approaches.

The project has been funded by the European Commission work programme 'Science with and for Society' in the Horizon 2020 Framework, within the programme topic 'SwafS-01-2018-2019-2020: Open schooling and collaboration on science education' to promote inclusive and equitable science.

1.2. Types of inspiring resources and aims of the catalogue

This catalogue includes a collection of inspiring resources for open schooling and stakeholder engagement, and has been developed with the collaboration of the CONNECT consortium partners and also conducting a literature review. It includes a total of 32 inspiring resources that have been selected based on a list of selection criteria that has been previously defined based on the dimensions of Responsible Research and Innovation (RRI) and on new trends in STEM education.

Therefore, the catalogue includes educational resources that engage students in methodologies such as: problem-based learning, participatory action research, system thinking, open innovation and citizen science, among others. The methodologies have been grouped into the following categories:

- learning through: students centred and systemic approaches; research; innovation; collaboration; critical thinking; evaluation;
- learning for inclusivity and for change;
- learning about career pathways and
- potential to scale and spread innovations.

The methodologies included in the Selection Criteria are just a sample of the wide variety that have been identified within toolkits such as those developed through previously EC funded projects on RRI, which include a wider variety of tools that can be further inspiring for the project. Those toolkits include the RRI tools ("About RRI - RRI Tools", 2020) which at the same time includes some tools targeted to educators to design and implement RRI-oriented practices (such as "How to integrate RRI in secondary education - RRI Tools", 2020) or the Action Catalogue ("Engage2020 Action Catalogue", 2015). Other methodologies can also be identified in other catalogues of co-creation and brainstorming tools such as Gamestorming ("Gamestorming", 2020). At the end of the Catalogue we have included a glossary defining some of the methodologies and approaches included in the different selection criteria.

The catalogue contains projects and practices, which include lesson plans, activities, interventions and networks, distributed in two different sections: one for 'inspiring Open Schooling resources', and another one with 'other inspiring resources' from outside education, as they can be inspiring to design educational activities to run with students.

However, the inspiring resources are also a sample of the wide variety of inspiring resources that can be found within catalogues, that can also be inspiring for the project, such as the Education for Sustainable Development Goals: learning objectives ("Education for Sustainable Development Goals: learning objectives", 2017), a resource that identifies learning objectives, and suggests topics and examples of learning activities for each SDG, or Scientix ("Home - Scientix", 2020), a repository of educational activities developed by the European SchoolNet.

The aim of this catalogue is to provide educational resources that can serve as inspiration for partners and stakeholders to develop the CONNECT educational materials. It can also serve as inspiration for any stakeholder willing to innovate in STEM education with Open Schooling resources. This catalogue will be made available in an online format through the CONNECT website, which will facilitate the search of resources by selection criteria.

1.3. Selection criteria to choose the inspiring resources

A collaborative work between partners in the project and the Living Lab for Health at IrsiCaixa has been developed to define the criteria to select the inspiring resources according to our objectives. A first review of the existing literature and a brainstorming within the Living Lab led to a first list of criteria that was shared with all partners in the CONNECT project to request feedback. All the suggestions were analysed by the IrsiCaixa Living Lab and a final description of ten criteria was elaborated. A part from this

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list of criteria, it was also agreed that all the selected inspiring resources would also have to be available in open access and in English.

The list of criteria, together with a description, is available in Table 1. It also includes a selection of some of the inspiring resources that illustrate how each selection criteria has been implemented.

To select the inspiring resources included in this catalogue a participatory process was facilitated where all partners from the consortium where invited to suggest candidates of resources. Among those, the Living Lab discarded those that were not available in English or in open access, or that did not fit into any of the selection criteria. The final list of selected inspiring resources can be found in Table 2, where each resource is classified as a project or practice and as an 'Open Schooling resource' or as 'Other inspiring resources'.

Criteria	Description	Key examples of inspiring resources that fulfil this criteria
1. Learning through students centred and systemic approaches	Student-centred learning is an approach to education that focuses on the learners and their needs to construct knowledge whereas teachers act as facilitators of learning experiences. This approach contributes to move from traditional teaching as transmissive approaches that focus on content-based learning to collaborative learning by which students are protagonists. Under this criteria we include resources with methodologies such as Problem-Based Learning, Inquiry Based Science Education, Inquiry games, Inquiry workflow, AR inquiry games, Gamification, System Thinking, cooperative learning and competency-based learning, among others.	CRISS H2020 (p.19) ENGAGE (p.21) XPLORE HEALTH (p.45)
2. Learning through research	Students learn through research projects defined and implemented with the collaboration of different stakeholders and, if necessary, with integration of knowledge from different academic disciplines. Under this criteria we include resources with methodologies such as Open science, Community Based Participatory Research, Participatory Action Research, citizen science, learning approaches linked to monodisciplinary, interdisciplinary and transdisciplinary research.	CIMULACT (p.45) EnRRICH (p.21) NATIONAL GEOGRAPHIC CITIZEN SCIENCE (p.28)
3. Learning through innovation	Students learn through innovation projects where they ideate, validate and prototype new products, processes, services, policies… Under this criteria we include resources with methodologies such as Open innovation, Design thinking, Do it yourself, hackathons, co-creation ...	OPEN DATA (p.30) SCHOOLAB (p.37) STUDENT INNOVATION LAB (p.41)
4. Learning through collaboration	Students learn through collaborative projects on home related science with different stakeholders, such as scientists, families/parents/guardians, other schools/educational platforms, CSOs, local communities or	CO2LAB (p.16) COMMUNITY SERVICE

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	industry. Through the collaborative project, they communicate, reflect, anticipate and are open to change the process at all phases of transdisciplinary processes. Under this criteria we include resources with collaborative methodologies in Science Education such as Open schooling, public engagement, service learning …	LEARNING at VU University (p.17) INGENIOUS (p.25)
5. Learning for inclusivity	Inclusive learning and teaching recognises all student's entitlement to a learning experience that respects diversity, enables participation, removes barriers and anticipates and considers a variety of learning needs and preferences. Under this criteria we include resources with special focus on vulnerable schools/students, dropout prevention, gender, no internet nor digital equipment, ...	EUROPEAN TOOLKIT FOR SCHOOLS (p.23) HYPATIA (p.25) PERFORM (p.32)
6. Learning about career pathways	Students learn about STEM and at the same time about possible groups of occupations within a career cluster in order to help them to consider the option to be a future scientist. Under this criteria we include resources or methodologies for disseminating different career pathways, that involve STEAM professionals acting as role models or ambassadors, that foster connections between Science and Student's entrepreneurship, that involve interaction between students and scientists ...	NTSE Virtual Lab (p.29) SPACE EU (p.39) STEM LEARNING Network (p.40)
7. Learning through critical thinking	Students learn to actively and skilfully conceptualize, apply, analyse, synthesize, and/or evaluate information gathered from, or generated by, observation, experience, reflection, reasoning, or communications, as a guide to belief and action. Under this criteria we include resources to facilitate self and co-reflection around norms and rules, ethical aspects, assumptions, uncertainties, anticipation, responsiveness ...	SCIENCE UPD8 (p.38) PLAY DECIDE: VACCINES, KEY TOOLS FOR PREVENTION (p.33)
8. Learning for change	Students learn through processes of participatory democracy to promote change in policies involving different stakeholders underpinned by science knowledge and skills, to promote changes in governance, services, products, infrastructures, communication channels and environments, collaborations, training, … Under this criteria we include resources or methodologies of participatory democracy such as scientific parliaments, citizen juries, ...	STUDENT PARLIAMENT (p.42) STUDENTS AS CHANGE AGENTS (p.43)
9. Learning through evaluation	Students learn through the evaluation process through formative evaluation supported by peers, experts, families and science educators, that will evaluate the different criteria included in this table, and also the quality of the learning processes including criteria linked to science capital, as those defined by CONNECT.	EDUTOPIA (p.19) NTSE Virtual Lab (p.29)

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	Under this criteria we include resources or methodologies of formative evaluation such as exit tickets, quizzes, polls, dipsticks, focused observation forms, interviews, rubrics…	
10. Potential to scale and spread innovations	Students learn through initiatives that scale and are implemented across a large variety of entities/educational centres/organizations and across territories. Under this criteria we include resources co-created within networks of schools in collaboration with different stakeholders (by schools and for schools) and with capacity to disseminate their findings.	EUROPEAN SCHOOLNET (p.22) HYPATIA (p.24)

Table 1. Criteria to select inspiring resources for Open Schooling

	Title	Format
Open Schooling	**Approve a new vaccine!**	Practice
	CO2LAB (Coronavirus Community Lab)	Practice
	Community Service Learning at VU University of Amsterdam	Practice
	CRISS H2020: Acquisition, assessment and certification of students' digital competence in primary and secondary school	Project
	EDUTOPIA	Practice
	ENGAGE: Equipping the next generation	Project
	EnRRICH -Community Based Participatory Research Module	Practice
	European Schoolnet	Practice
	European Toolkit for Schools	Practice
	Hypatia project	Project
	InGenious	Project
	Innovative Practices for engaging STEAM careers teaching	Practice
	IRRESISTIBLE	Project
	National Geographic Citizen Science	Practice
	NTSE Virtual Lab	Practice
	Open Education Hackdays: Shaping the Future of Education through Open Innovation	Practice
	Open Schools for Open Societies (OSOS)	Project
	PERFORM: Participatory Engagement with Scientific and Technological Research through Performance	Project
	Play decide: Vaccines, key tools for prevention	Practice
	PROFILES	Project
	Sana Ment (Healthy Mind)	Practice
	School Education Gateway	Project
	SCHOOLAB Innovation Studio	Project
	SCIENCE UPD8	Practice
	SpaceEU	Project
	STEM learning Network	Practice
	Student Innovation Lab (SIL)	Practice
	Student parliament	Practice
	Students as Change Agents	Practice
	Xplore Health	Project
Other inspiring resources	**CIMULACT (Citizen and Multi Actor Consultation)**	Project
	RiConfigure: The Social Lab Methodology Manual	Practice

Table 2. List of inspiring resources included in the catalogue

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Find below a description of each selection criteria and how they can inspire Open Schooling resources

Learning through student-centred and systemic approaches

Methodologies such as Problem-based learning, Inquiry Based Science Education, Inquiry workflow, Inquiry games, System Thinking or competency-based learning, among others, promote learning through student-centred and systemic approaches and focus on the learners' needs while engage students to play a central role in knowledge construction. A wide variety of examples of educational resources that implement these methodologies, lesson plans and guidelines for teachers can be found within the ENGAGE and the XPLORE HEALTH projects' toolkits.

Learning through research

Resources with Open Science methodologies allow students learning through real research projects, which are defined and implemented in collaboration with different stakeholders within the education community (teachers, families), the research community (scientists from different disciplines), policy makers, civil society organizations and/or industry representatives. The Community Based Participatory Research educational module developed by the EnRRICH project, the citizen and multi-actor consultation to explore the needs for research within the CIMULACT project and the National Geographic Citizen Science initiatives illustrate how students can be engaged in collaborative research as a form of learning.

Learning through innovation

Some innovative methodologies also promote student learning through innovation projects where they ideate, validate and prototype new products, processes, services and policies. As an example, Open Data showcases how a methodology called hackathon that offer students the opportunity to elaborate solutions for real-life challenges in collaboration with external partners; Student Innovation Lab and Schoolab, which also promotes the creation of Innovation Labs, act as hubs or incubators for innovation and empower students to maximize their innovation potential and apply theoretical foundations in future-oriented technologies.

Learning through collaboration

In Open Schooling students learn together in an engaging environment where students' projects meet real needs in their community outside the school. In this sense, learning through collaboration enable them to communicate, reflect, anticipate and be open to changes needed in the community. The Community Service Learning unit at VU University in Amsterdam exemplifies how an education centre, in this case a university, can promote this form of education. Co2Lab, illustrates how educational guidelines can be developed to guide students through the process of service learning and participatory research by facilitating a step-by-step process description with inspiring methodologies, such as system thinking, in this case.

Learning through critical thinking

In Open Schooling STEM teaching it is also important to facilitate self- and co-reflection in order to expand students' skills on scientific reasoning to promote learning through critical thinking. This implies activities that invite students to carry out analysis, synthesis

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and evaluations to provide evidence-based argumentation for decision-making, as the UPD8 science-in-the-news based activities or the play decide card game “Vaccines, Key tools for prevention”, where students are challenged to debate about a controversial issues as vaccination while stimulating critical thinking.

Learning through evaluation

Pedagogical activities that include methodologies to do formative evaluation contribute to meaningful learning processes where students learn through evaluation supported by teachers and other stakeholders. EDUTOPIA illustrates the variety of methodologies that can be used for formative evaluation, which include assessment grids that are used in some practices of this catalogue, as for example the NTSE Virtual Lab activities.

Learning for inclusivity

Inclusive teaching strategies contribute to a learning environment in which diversity is respected and awareness is created about the variety of learning needs that should be targeted in a learning process. Thus, resources with special focus on vulnerability (i.e. low socio-economic level and lack of access to internet and digital equipment), gender or dropout prevention contribute to remove barriers and enable participation of all students the learning process. In this sense, Hypatia’s toolkit offers modules focused on gender-inclusive ways of educating and communicating STEM; PERFORM’s toolkit includes guidance on integrating performing techniques in STEAM teaching through activities with recommendations for girls’ inclusion and students from low socio-economic backgrounds and the European Toolkit for Schools tackles specifically early school leaving.

Learning for change

Participatory democracy plays a central role in the promotion of changes in policies, governance, services and products, among others, with methodologies that involve a wide variety of stakeholders. Therefore, students can be engaged with these methodologies to empower them as change agents. Resources such as scientific parliaments or citizen juries prepare students to take part as active citizens in the knowledge society through debates, negotiation and construction of knowledge around scientific issues which promote interaction among scientists and young people. The programme “Students as change agents” of the Edinburgh University engage students to become change agents enabled to apply classroom knowledge to the real world and to potentially have an impact on it.

Learning about career pathways

Open schooling practices involve STEM professionals in different career pathways to play a role in science education, acting as role models or ambassadors. Their participation in academic activities not only contributes to foster interactions between students and scientists but also help to inspire students in science careers. The STEM Learning Network offers teachers a selection of resources and guidance to continuing professional development to promote career pathways in education and to bring STEM ambassadors to schools.

Potential to scale and spread innovations

The capacity of being widely implemented is another important feature that inspiring resources should have. When a resource is scalable and potentially spreadable it has a greater impact in promoting changes in science education. The European SchoolNet is

an example of network of schools that collaborate with different stakeholders to co-create resources that can be easily scalable.

See glossary for a detailed description of some of the methodologies and pedagogical approaches.

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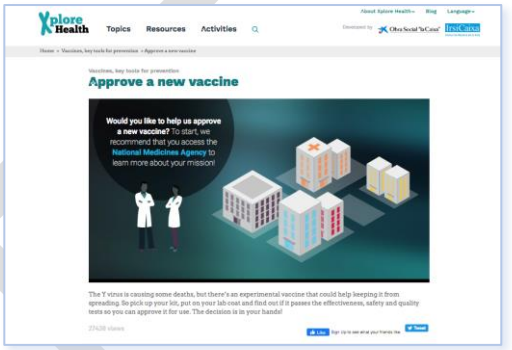
2. Catalogue of inspiring resources

2.1. Inspiring Open Schooling resources

Approve a new vaccine!		
Selection criteria	**Students' centred and systemic approaches** · **Research** · **Innovation** · **Collaboration** · **Inclusivity** · **Career pathways** · **Critical thinking** · **Change** · **Evaluation** · **Potential to scale/spread innovations**	
Leading organization	Living Lab for Health at IrsiCaixa in collaboration with Foundation "la Caixa" and the European project EnRRICH	
Target audience	Secondary school students	
Topics	• Vaccines • Drug research • Immunology	
Format	☐Project ☑Practice	
Digital proof	Multimedia resource (virtual experiment) to be used online or in face-to-face classrooms	
Description and inspiring factors	This practice is a virtual experiment by which students have the opportunity to act as researchers and practise decision-making based on **scientific reasoning**. The experiment is set on an open-ended scenario about a virus causing some deaths and an experimental vaccine that could help keeping it from spreading. The student have to find out if it passes the effectiveness, safety and quality tests and if it can be approved for use.	
Website and publications	Approve a new vaccine	

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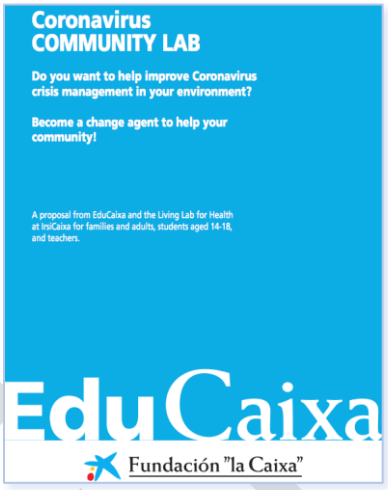
CO2LAB (Coronavirus Community Lab)

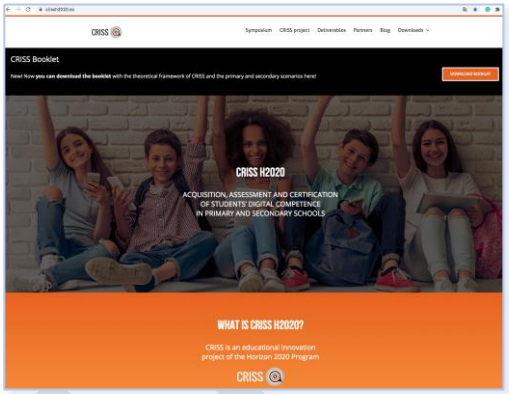
Selection criteria	**Students' centred and systemic approaches** · **Research** · Innovation · **Collaboration** · Inclusivity · Career pathways · **Critical thinking** · **Change** · Evaluation · Potential to scale/spread innovations
Leading organization	EduCaixa and the Living Lab for Health at IRSICaixa
Target audience	Families and adults, students aged 14-18 and teachers
Topics	• COVID19 disease • SARS-CoV-2 coronavirus • Pandemic evolution • Fake *versus* proven information
	
Format	☐Project ☑Practice
Digital proof	The working document is available online and can be implemented virtually
Description and inspiring factors	The Coronavirus Community Lab is a proposal to mobilise and empower citizens with knowledge and skills, to explore a particular situation in collaboration among different stakeholders and to implement solutions aimed at improving community health: physical and mental health, socialization, nutrition, rest, physical activity, etc. Participants work together as co-researchers to explore their situation and help generate evidence-based proposals for change. Those proposals are aimed at improving coronavirus crisis management and/or at creating a **citizen science** project to design **community action solutions**. This is an inspiring practice because the participants' working document follows a **system thinking** approach, by which a complex problem as the coronavirus pandemic is addressed by non-scientific individuals through a method to understand a system by examining the linkages and interactions between the elements that comprise the whole of the system. The guideline has been elaborated for the Spanish context of the Coronavirus crisis. However, it can be implemented in other countries by adapting the section containing the management of the health crisis and the bibliographic references in relation to the pandemic evolution.
Website and publications	Coronavirus Community Lab

COMMUNITY SERVICE LEARNING at VU University of Amsterdam

Selection criteria	**Students' centred and systemic approaches** · **Research** · **Innovation** · **Collaboration** · **Inclusivity** · **Career pathways** · **Critical thinking** · **Change** · **Evaluation** · **Potential to scale/spread innovations**
Leading organization	Vrije Universiteit Amsterdam
Target audience	University and Master students, teachers and partners from their community
Topics	• Loneliness • Inclusive mobility • Circular economy • Smoking policies • Sustainability • Digitalization • Globalization • Inequality
Format	☐Project ☑Practice
Digital proof	Lectures are given online but the implementation of the service learning can be implemented face-to-face or online depending on the project
Description and inspiring factors	The Community Service Learning (CSL) at VU University is a unit created within the university to promote a form of education in which students use their academic skills to solve currently existing social issues. This happens in close cooperation and interaction with a community partner. An important feature of how this university promotes CSL is the facilitation of **academic reflection** before, during and after the educational activity. These practices can be easily coupled to research and publications. For the students CSL has added value on an academic, professional and personal level. The most prominent example of improved academic skills is a deeper understanding of the scientific theory. When the CSL activities are properly related to the scientific knowledge on that theme, students will be encouraged to move between the real world and scientific theory. The professional added value for students is related to the improvement of communication skills and the development of their professional network. The personal added value of CSL revolves around diversity, openness to change and discovering new interests. This form of active education is inspiring as it is based in a not-for-profit **collaboration** where all members involved gain valuable experience with qualitative **community-based research** methods (interviews, group discussions) and the community obtains a sustainable solution for their need.
Website and publications	Community Service Learning at VU University

CRISS H2020: Acquisition, assessment and certification of students' digital competence in primary and secondary school

Selection criteria	**Students' centred and systemic approaches** · **Research** · **Innovation** · **Collaboration** · **Inclusivity** · **Career pathways** · **Critical thinking** · **Change** · **Evaluation** · **Potential to scale/spread innovations**
Leading organization	Leaded by a Consortium formed by EXUS Software LTD, Documenta Creaciones Multimedia Avanzadas S.L. and Universitat Oberta de Catalunya, among others.
Target audience	Primary and secondary school students and teachers
Topics	• Digital competence
Format	☑Project ☐Practice
Digital proof	Suitable for both face-to-face and online implementation
Description and inspiring factors	CRISS is an educational innovation project funded by Horizon 2020 Program. The purpose of CRISS H2020 is to develop and pilot an educational platform in the cloud for the **acquisition, evaluation, and certification of students' digital competence** in primary and secondary schools and for promoting more efficient and effective learning by incorporating new forms of learning with digital technologies. The project consists of evaluating a digital platform through and Innovative **competency-based assessment** and certification of learning framework, including self-evaluation and peer-to-peer evaluation. Teachers plan on the ePortfolio the learning and evaluation activities and tasks that students have to do and the students upload evidences of tasks on the platform and download their badges and certifications. The use of the CRISS platform is integrated into the normal activity of the class so that students develop digital competence while learning their curricula, with activities and pedagogical resources based on self-regulated **project-based learning** (PBL). They learn for empowerment through digital competence acquisition. Teachers are supported throughout the process with the implementations of measures such as a MOOC course, activities to help programming contents and access to the support service.
Website and publications	CRISS H2020



EDUTOPIA

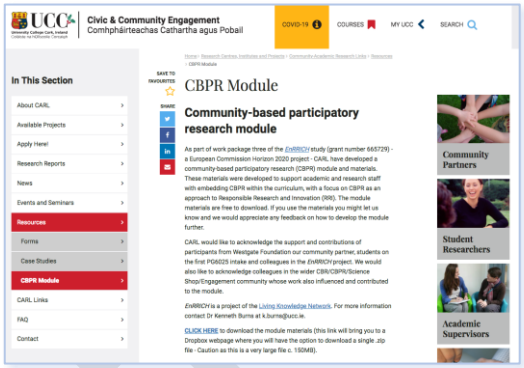
Selection criteria	**Students' centred and systemic approaches** · **Research** · **Innovation** · **Collaboration** · **Inclusivity** · **Career pathways** · **Critical thinking** · **Change** · **Evaluation** · **Potential to scale/spread innovations**
Leading organization	George Lucas Educational Foundation
Target audience	Teachers' community
Topics	• Assessment • Integrated studies • Project-based learning • Social and emotional learning • Teacher development • Technology integration
Format	☐Project ☑Practice
Digital proof	Suitable for both face-to-face and online implementation
Description and inspiring factors	The George Lucas Educational Foundations is dedicated to transform K-12 education so that all students can acquire and effectively apply the knowledge, attitudes and skills necessary to thrive in their studies, careers, and adults lives. This platform is a powerful repository of inspiring practices to do innovative teaching, classroom management and **formative assessment**, among others. The goal of formative assessment is to monitor student learning to provide ongoing feedback that can be used by instructors to improve their teaching and by students to improve their learning. More specifically, formative assessment helps students identify their strengths and weaknesses and target areas that need work. Formative assessments generally just need to be checked, not graded, as the point is to get a basic read on the progress of individuals, or the class as a whole. This website is inspiring because it compiles an interesting collection of tools for teachers to do formative assessment. Teachers can find up to 40 tools, tips and strategies for finding out what students know while they are still learning.
Website and publications	Edutopia

ENGAGE: Equipping the next generation

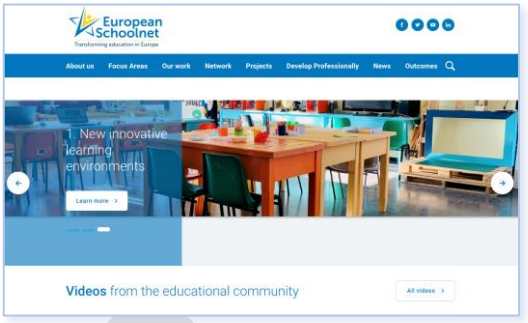
Selection criteria	Students' centred and systemic approaches; Research; Innovation; Collaboration; Inclusivity; Career pathways; Critical thinking; **Change**; Evaluation; Potential to scale/spread innovations	
Leading organization	ENGAGE Consortium, which included 14 institutions from 13 countries	
Target audience	Students, teachers, educational researchers and scientists willing to implement outreach activities	
Topics	• Technology impact • Earth, Ecosystem, Electromagnetism, Energy, Forces, Genes, Matter, Organisms, Reactions, Waves • Values thinking • Science-Media	
Format	☑Project ☐Practice	
Digital proof	Suitable for both online and face-to-face implementation	
Description and inspiring factors	ENGAGE is a project about equipping the next generation to participate in scientific issues by changing how science is taught. The great challenge of the project is to help teachers develop the beliefs, knowledge and classroom practice for applying changes in their approach to science teaching with inspiration from RRI dimensions. Traditionally students' gain an image of science as a body of content, whereas in this project students are also invited to deal with uncertain areas of knowledge, where values and argument matter as much as facts. ENGAGE promotes learning through a **student's centred approach**, focusing on an inquiry-based methodology, which gives students opportunity for self-expression and responsibility for coming to informed decisions. All pedagogical materials are designed to address contemporary science throughout relevant challenges to students. Some of the tools are specifically designed to develop **critical thinking**. For example, in the '3 Parents Breaking News' activity related to inheritance or in the didactic sequence about Fracking, students are asked to critically read media reports about science, identify data, evidence and values thinking used to back up the claims, as well as evaluate its strength in terms of repeatability and reproducibility. Students are also asked to reflect around ethical issues by facing them to human dilemmas, such as those around genetic testing or around making decisions about carriers related with an inherited condition having descendants affected by it. Stakeholders support resources for **formative evaluation**. The ENGAGE project is part of the EU Science in society agenda to promote RRI. ENGAGE combines non-formal resources (e.g. using science-in-the-news) and informal learning (e.g. promoting collaboration with scientists) with formal education (e.g. focusing on science curriculum).	
Website and publications	ENGAGE ENGAGE-related publications	

EnRRICH -Community Based Participatory Research Module

Selection criteria	**Students' centred and systemic approaches** · **Research** · **Innovation** · **Collaboration** · **Inclusivity** · **Career pathways** · **Critical thinking** · **Change** · **Evaluation** · **Potential to scale/spread innovations**
Leading organization	University College Cork (UCC), Ireland
Target audience	Post-graduate students
Topics	• Principles and strategies to run a CBPR • Sustainability of a CBPR • Research design • Relevance of research in society
Format	☐Project ☑Practice
Digital proof	Suitable for both online and face-to-face implementation
Description and inspiring factors	The Community Based Participatory Research (CBPR) Module is an inter-disciplinary university course that has been developed as part of EnRRICH, an EC funded project to promote innovation in higher education through science shops structures. The materials of this Module were developed by University College Cork and the Westgate Foundation to support academic and research staff with embedding CBPR within the curriculum, with a focus on CBPR as an approach to Responsible Research and Innovation (RRI). The module materials include a handbook, resources, slides and exercises and are free to download or adapt. Through this practice students learn how to carry out a CBPR in a meaningful and impactful way, and to understand how they and their community partners' respective skills and experiences can be exchanged for mutual benefit and growth and for the prosperity of wider society. The module also seek to support and serve as a blueprint for the design of future CBPR studies. The module addresses RRI keys as Public/Societal engagement; Open access; Ethics; Governance or Social Justice. It also covers RRI process requirements as Diversity and Inclusion; Anticipation and Reflection; Openness and Transparency and adaptive change.
Website and publications	EnRRICH - Community Based Participatory Research Module



EUROPEAN SCHOOLNET

Selection criteria	**Students' centred and systemic approaches** · **Research** · **Innovation** · **Collaboration** · **Inclusivity** · **Career pathways** · **Critical thinking** · **Change** · **Evaluation** · **Potential to scale/spread innovations**	
Leading organization	34 European Ministries of Education	
Target audience	Ministries of Education, schools, teachers, researchers, and industry partners	
Topics	• Innovation in education	
Format	☐Project ☑Practice	
Digital proof	The network facilitates resources and networking activities both for online and face-to-face implementation	
Description and inspiring factors	European Schoolnet is the network of 34 European Ministries of Education, based in Brussels. Its mission is to support education stakeholders in Europe in the transformation of education processes for 21st century digitalized societies. They bring innovation in teaching and learning to key stakeholders as Ministries of Education, schools, teachers, researchers, and industry partners. They identify and test promising innovative practices, share evidence about their impact and support the mainstreaming of teaching and learning practices aligned with 21st century standards for inclusive education. The European Schoolnet is a model of **network** with different working groups involving several countries where innovation schooling and learning projects can be born, developed and disseminated, thus contributing to their **scalability**. School Networking projects such as eTwinning and the School Education Gateway website facilitate networking opportunities for schools to work in collaboration at international level.	
Website and publications	European SchoolNet	

European Toolkit for Schools

Selection criteria	**Students' centred and systemic approaches** · **Research** · **Innovation** · **Collaboration** · **Inclusivity** · **Career pathways** · **Critical thinking** · **Change** · **Evaluation** · **Potential to scale/spread innovations**
Leading organization	School Education Gateway, steered by the European Commission
Target audience	School leaders, teachers, parents and other people involved in education
Topics	• School governance • Career paths • Citizenship • Classroom management and tools (CBL, Gamification…) • Cultural diversity and heritage • Entrepreneurship • Digital competence
	
Format	☐Project ☑Practice
Digital proof	Suitable for both online and face-to-face implementation
Description and inspiring factors	The European Toolkit for Schools offers concrete ideas for improving **collaboration** within, between and beyond schools with a view on enabling all children and young people to succeed in school. The aim is promoting inclusive education and tackling early school leaving. The toolkit provide guidelines and resources that can be useful for school leaders, teachers parents and people involved in school life to inspire their efforts in providing effective and high-quality early childhood and school education to prevent early school leaving. The aim of the Toolkit is to support the exchange and experience among school practitioners and policy makers. The resources available in the Toolkit are organised around five areas: school governance, teachers, and support to learners, parental involvement and stakeholders' involvement. These five areas have been divided in a number of subareas, which contain examples of specific school-level actions. Each subarea provides: • a short explanation as to why this dimension is important for learners' success and prevention of early school leaving, with evidence from research, examples of interventions at the school level and links to further reading; • a number of resources, ranging from research studies, project reports, to concrete examples of good practices describing how a measure was successfully implemented.
Website and publications	European Toolkit for Schools

Hypatia project

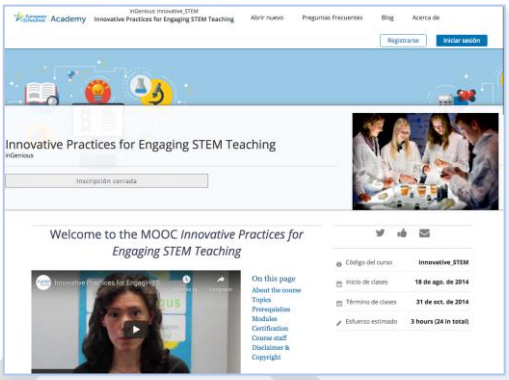
Selection criteria	Students' centred and systemic approaches · Research · Innovation · Collaboration · Inclusivity · Career pathways · **Critical thinking** · Change · Evaluation · Potential to scale/spread innovations
Leading organization	NEMO Science Museum (The Netherlands) and carried out by 19 partners from 15 countries.
Target audience	Students, teachers, non-formal learning organizations, researchers industry and policy makers.
Topics	• Science • Technology • Engineering • Mathematics
Format	☑Project ☐Practice
Digital proof	Suitable for face-to-face implementation but easy to adapt them for online implementation
Description and inspiring factors	Hypatia is an EU Horizon 2020 funded project that aims to develop a theoretical framework on **gender inclusive** STEAM education and to produce, test and promote a toolkit with practical solutions and modules for schools, businesses and science centres and museums across Europe. The modules in the toolkit are intended to empower teenagers with the range of skills that are needed for a great variety of **STEM careers**. To contribute to scale and spread these activities national Hubs were created to translate, adapt and implement pedagogical modules to the national context of 14 participant countries. Events organized for teachers, head teachers, representatives of industries, policy makers and teenagers helped to disseminate the toolkit to be used widely across Europe. Hypatia's toolkit contains innovative activities such as workshops, speed dating, card games, debate scenarios and plays drawn from good practices around Europe. Each module has a central focus on **gender-inclusive** ways of communicating STEM. Every activity contains gender and facilitation teaching guidelines.
Website and publications	Hypatia project Hypatia's toolkit

InGenious

Selection criteria	Students' centred and systemic approaches; Research; Innovation; Collaboration; Inclusivity; Career pathways; Critical thinking; Change; Evaluation; Potential to scale/spread innovations
Leading organization	European Schoolnet and the European Roundtable of Industrialists (ERT)
Target audience	Students, students' parents, teachers, industry and policy makers
Topics	• Science • Technology • Engineering • Mathematics
Format	☑Project ☐Practice
Digital proof	It facilitates both online and face-to-face activities
Description and inspiring factors	InGenious is a digital repository of practices facilitated by a European Coordinating initiative in STEAM Education. It aims to reinforce young European's interest in science education and STEM careers and encourage students to think about the wide range of interesting opportunities that STEM can bring to their lives in the future. The InGenious database is a searchable living repository of practices and policies within STEAM sectors that outlines different types of practices tested by teachers and the polcies put in place to facilitate them. This project has been developed with strong **collaborations** between the education community and industry. InGenious has also developed a **Code of conduct** for school and industry collaboration. It offers a solid bases for **cooperation** and gives both sides a shared set of principles and guidelines based on common sense, courtesy and mutual respect to put in practice. **Communities of practice (CoP)** have been created within the ingenious Teacher and Partners Communities. CoP are exchange and discussion groups focused on a particular theme suggested by an expert over a six week period. **Competitions** are also organized by InGenious to engage students' participation and evaluate implementation, as the one aimed to raise pupils' awareness on STEM studies.
Website and publications	InGenious

Innovative Practices for engaging STEAM careers teaching

Selection criteria	**Students' centred and systemic approaches** · **Research** · **Innovation** · **Collaboration** · **Inclusivity** · **Career pathways** · **Critical thinking** · **Change** · **Evaluation** · **Potential to scale/spread innovations**
Leading organization	European Schoolnet with the support of the InGenious project
Target audience	Teachers, school counsellors, career advisors and anyone with an interest in STEM
Topics	• Science • Technology • Engineering • Mathematics
Format	☐Project ☑Practice
Digital proof	Online MOOC course
Description and inspiring factors	This course aims to provide resources and ideas to increase student's interest for STEAM subjects and careers in response to the worrying disengagement of young people from STEM subjects in school and their decreased interest in related careers. The course is structured into 8 modules, which develop a learning path from the analysis of the reasons behind students' disaffection for STEM to the development and experimentations with innovative practices to overcome it. The first 5 modules focus on **motivating and engaging** students in the STEM area through different approaches such as taking part in virtual visits to research centres and the use of virtual and remote labs and other innovative tools in the classroom. The last 3 modules explore **career-counselling** aspects, providing guidance on how to inform students about career pathways. A digital module badge is received for every completed module as well as a course badge and a course certificate upon completion of the full course. Portugal formally recognizes this course as valid continuous professional development.
Website and publications	Innovative Practices for Engaging STEAM Teaching (closed registrations but content available for self-learning)

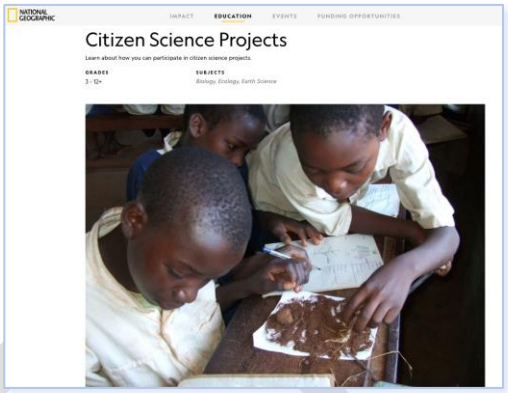


IRRESISTIBLE

Selection criteria	**Students' centred and systemic approaches** · Research · Innovation · **Collaboration** · Inclusivity · Career pathways · **Critical thinking** · Change · **Evaluation** · **Potential to scale/spread innovations**
Leading organization	University of Groningen in collaboration with 14 partners in 10 countries. Project funded by European Union FP7 program
Target audience	Students, teachers, educational researchers, scientists and others related with non-formal education
Topics	Each partner developed a thematic module: • Healthy ageing • Genomics and oceanography • Oceanography and climate change • Climate change • Renewable energy sustainability • Nanomaterials • Nanoscience • Nanoscience applications • Nanoscience and nanotechnology • Nanotechnology (catalysis)
Format	☑Project ☐Practice
Digital proof	Suitable for face-to-face implementation
Description and inspiring factors	IRRESISTIBLE is the acronym of Including Responsible Research and innovation in cutting Edge Science and Inquiry-based Science education to improve Teacher's Ability of Bridging Learning Environments. The project IRRESISTIBLE designed activities that foster the **involvement of students and the public** in the process of Responsible Research and Innovation (RRI). The consortium aimed to raise awareness on RRI by increasing pupils' content knowledge about research. For this purpose, a combination of formal (school) and informal (science centre, museum or festival) educational approaches was used to introduce relevant topics and cutting edge research into the programme. The modules are available for download from the website in different languages and they were developed by school teachers, education experts from universities, exhibition experts from museums and science centres and researchers from the respective thematic field. They include **inquiry based (IBSE) elements** for students and foster the aspects of **Responsible Research and Innovation (RRI)** in different ways. The modules were adapted to the school systems in different countries.
Website and publications	IRRESISTIBLE

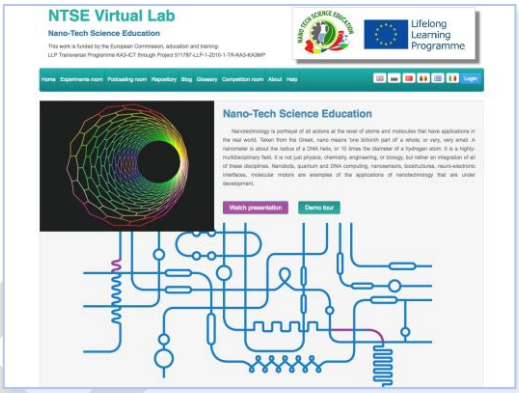
NATIONAL GEOGRAPHIC CITIZEN SCIENCE

Selection criteria	**Students' centred and systemic approaches** ; **Research** ; **Innovation** ; **Collaboration** ; **Inclusivity** ; **Career pathways** ; **Critical thinking** ; **Change** ; **Evaluation** ; **Potential to scale/spread innovations**
Leading organization	National Geographic Society
Target audience	Students aged 3 to 12
Topics	• Biology • Ecology • Earth sciences
Format	☐Project ☑Practice
Digital proof	Activities to be implemented online
Description and inspiring factors	The National Geographic Citizen Science is a platform offering a repository of several citizen science projects in which volunteers and scientists work together to answer real-world questions and gather data. This approach is inspiring because it promotes **citizen engagement** in scientific research, **facilitates research** on a bigger scale, improves **openness** and **reliability** of research and **scientific literacy** (citizens and scientists increase their own knowledge and understanding about science). The platform offers links to interesting projects available for citizen participation, which allow students making their contribution to initiatives such as a census of butterflies in North America or helping scientists to classify galaxies or collecting weather data, among others.
Website and publications	National Geographic Citizen Science projects



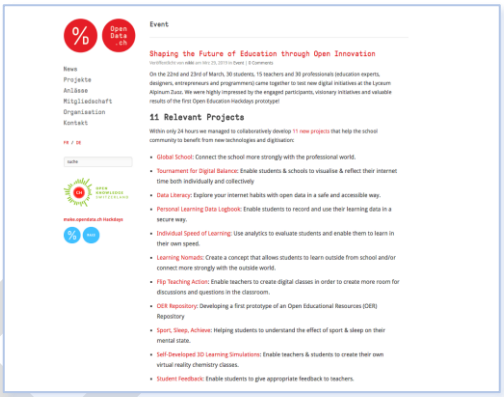
NTSE Virtual Lab

Selection criteria	**Students' centred and systemic approaches** · **Research** · **Innovation** · **Collaboration** · **Inclusivity** · **Career pathways** · **Critical thinking** · **Change** · **Evaluation** · **Potential to scale/spread innovations**
Leading organization	Döga Schools (Turkey) in collaboration with other 5 NTSE partners in Italy, Bulgaria, Greece and Romania. Project funded by the European Commission
Target audience	Students from the general and vocational schools aged 13 to 18; science teachers, college and university students attending science education courses
Topics	• Nanoscience • Chemistry • Physics
Format	☐Project ☑Practice
Digital proof	Suitable for face-to-face implementation but it can easily be adapted for online implementation
Description and inspiring factors	Nano Technology Science Education (NTSE) is a project aimed to use ICTs as a tool to make the learning of science subjects more attractive and accessible. The project established a **Virtual Lab**, as an experimental virtual aid to science learning. This is served as a platform for science lessons, as a database of teaching materials and as a hub for science-learning-related graphic aids and recorded and illustrated appealing experiments on Nano-Tech. The project included a Nano-Science Centre, presenting to learners and their in-service or future teachers the miracles of the nanotechnologies and a program for a week **Science Camp training** including hands-on experiments and demonstrations. The Experiments Room of the NTSE Virtual Lab offers up to 10 powerful practices that include support videos, student guides, teaching guides and **assessment grids**. In the Podcasting Room there is a module containing videos and scientists' interviews focused on promoting **careers of female scientists**.
Website and publications	NTSE Virtual Lab NTSE project website



Open Education Hackdays: Shaping the Future of Education through Open Innovation

Selection criteria	**Students' centred and systemic approaches** · Research · **Innovation** · **Collaboration** · Inclusivity · Career pathways · Critical thinking · **Change** · Evaluation · Potential to scale/spread innovations
Leading organization	Collaboration between Kickstart Innovation, Lyceum Alpinum Zuoz, Gerbert Rüf Stiftung and coordinated by Opendata.ch
Target audience	Students, teachers and professionals (education experts, designers, entrepreneurs and programmers)
Topics	The hackathon developed 11 projects related with education: • Global School • Digital balance • Data literacy • Personal Learning Data Logbook • Individual Speed of Learning • Learning Nomads • Flip Teaching Action • OER repository • Sport, Sleep, Achieve • Self-Developed 3D Learning Simulations • Student feedback
Format	☐Project ☑Practice
Digital proof	This project was implemented face-to-face but it could also be organised online
Description and inspiring factors	A hackathon is a hands-on, solution-based development model with similarities to **PBL**, **inquiry-based learning**, and **design thinking** by which students use their skills and knowledge to solve problems. In an education hackathon event students work **collaboratively** within mixed-ability groups to examine problems and come up with solutions. Opendata.ch is a section of the Open Knowledge Foundation and organises several Hackdays every year in order to strengthen open data as well as open and interdisciplinary **innovation** in all kinds of sectors, from farming to multilingualism. The Open Education Hackdays was organized in 2019. Within only 24 hours they managed to collaboratively develop 11 new projects that help the school community to benefit from new technologies and digitisation. Participants were 30 students, 15 teachers and 30 professionals (education experts, designers, entrepreneurs and programmers) that came together to test new digital initiatives at the Lyceum Alpinum Zuoz. The participants came up with visionary initiatives and valuable results.
Website and publications	Open Data

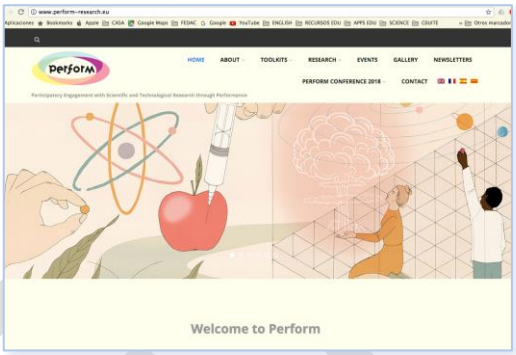


Open Schools for Open Societies (OSOS)

Selection criteria	**Students' centred and systemic approaches** · Research · Innovation · **Collaboration** · Inclusivity · Career pathways · Critical thinking · **Change** · Evaluation · Potential to scale/spread innovations
Leading organization	OSOS Consortium coordinated by Ellinogermaniki Agogi partially funded by the European Comission (EC).
Target audience	Primary and secondary school students
Topics	• Open Schooling • Partnerships • Science • Technology • Engineering • Mathematics
Format	☑Project ☐Practice
Digital proof	Content is available online but material is designed to be implemented face-to-face.
Description and inspiring factors	The OSOS project aims to open up schools to the society: student **projects meet real needs** in the community outside school and **draw upon local expertise and experience**. The project supports schools to implement open schooling approaches. First of all, the project has developed an Open School Model, that provides school leaders with a powerful framework that can help them to **transform to an open school**, giving a strong emphasis on the **Responsible Research and Innovation (RRI) dimensions.** Moreover, the project sets out the open schooling values and principles for action around curriculum, pedagogy and assessment, and schools are offered guidelines and advice on issues such as staff development or redesigning time and partnerships with relevant organisations (local industries, business, research centres, parents and policy makers). Finally, the project offers a range of possible implementation models from small-scale prototypes through to setting up an "open school within a school" or even designing a new school. The OSOS portal includes **innovative science resources and activities** for teaching with an **emphasis on social responsibility** and on **interdisciplinary learning scenarios**.
Website and publications	Open Schools for Open Societies

PERFORM: Participatory Engagement with Scientific and Technological Research through Performance

Selection criteria	Students' centred and systemic approaches; Research; Innovation; Collaboration; Inclusivity; Career pathways; Critical thinking; Change; Evaluation; Potential to scale/spread innovations
Leading organization	PERFORM Consortium coordinated by the Open University in Catalonia. Project funded by European Commission (EC)
Target audience	Secondary school students
Topics	• Science • Technology • Engineering • Mathematics
Format	☑Project ☐Practice
Digital proof	For face-to-face implementation in the classroom
Description and inspiring factors	The PERFORM project aims to investigate the effects of the use of innovative science education methods based on performing arts in fostering young peoples' motivations and engagement with STEM in selected secondary schools in France, Spain and the UK. Storytelling and drama, including stand-up comedy monologues, improvisation, clowning and science busks creation, were used as engaging ways of helping people to understand the societal and ethical implications of scientific research, with special focus in girls and students from low socio-economic backgrounds. PERFORM brought together students, teachers, performance artists and early career science researchers to develop interactive performances and engage in discussions about science and society. PERFORM's toolkit includes **performance and discussion-based activities** that will help students to develop key skills and reflect about science, as the **performing science cards** that support students to explore **ethical issues** related to scientific research and its impact on society and short **videos** introducing students to real **science researchers** from across Europe to challenge stereotypes about science. The toolkit also provides guidance on integrating performing techniques and discussion on science and society into lessons.
Website and publications	PERFORM PERFORM's toolkit



Play decide: Vaccines, key tools for prevention

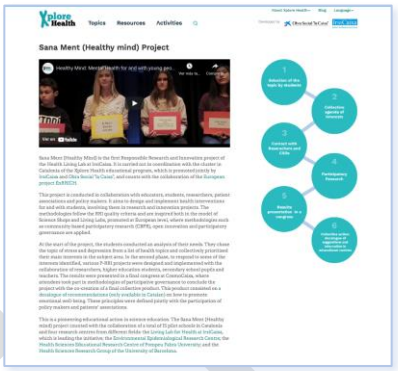
Selection criteria	**Students' centred and systemic approaches** · Research · **Innovation** · Collaboration · Inclusivity · Career pathways · **Critical thinking** · Change · Evaluation · Potential to scale/spread innovations
Leading organization	Living Lab for Health at IrsiCaixa in collaboration with Foundation "la Caixa" and the European project EnRRICH
Target audience	Secondary school students
Topics	• Vaccines • Infectious diseases • Ethics • Epidemiology
Format	☐Project ☑Practice
Digital proof	Multimedia content is available online but teaching guides and card resources are designed to be implemented face-to-face. However, they could easily be adapted for online implementation.
Description and inspiring factors	The Play Decide: 'Vaccines: key tools for prevention' is a game to engage in a dialogue. The activity is set in the context of vaccines that help to save the lives of 2.5 million children every year. They are one of the most useful and cost-effective public health measures. However, there are groups that refuse to get vaccinated for different reasons. This not only exposes them to serious health risks, it also jeopardises other people who can't get vaccinated. When the number of vaccinated people in a population drops, some infectious diseases can reappear, as happened with diphtheria in Spain in 2015. This game addresses some controversial aspects surrounding vaccinations and allows having a simple and factual debate. This debating game is designed to be played in groups of 4 to 8 people for a minimum of 60 to 90 minutes. The Play Decide website also offers a wide variety of card games around other controversial issues.
Website and publications	Play decide: Vaccines, key tools for prevention

PROFILES

Selection criteria	**Students' centred and systemic approaches** · Research · Innovation · Collaboration · Inclusivity · Career pathways · **Critical thinking** · Change · Evaluation · Potential to scale/spread innovations
Leading organization	PROFILES Consortium coordinated by the Division of Chemistry Education of Freie Universität Berlin.. Project funded by the European Comission (EC).
Target audience	Teachers, students, educational researchers and other stakeholders such as scientitst
Topics	• Biology • Geology • Physics • Mathematics • Chemistry
Format	☑Project ☐Practice
Digital proof	Content is available online but material is designed to be implemented face-to-face.
Description and inspiring factors	The PROFILES (Professional Reflection-Oriented Focus on Inquiry-based Learning and Education through Science) project aims at disseminating **Inquiry-Based Science Education** (IBSE). To achieve this, the project offers **innovative learning environments** (teacher training materials and IBSE educational modules) and **programmes for the enhancement of teachers' continuous professional development** (trainings for teachers to implement educational modules in the classroom). Both supportive action strategies aim to raise the self-efficacy of science teachers to enable them to take ownership in more **effective ways in science teaching**, so as much students as possible benefit from the PROFILES teaching modules and approaches. All participants involved in the PROFILES project are supported by **stakeholders from different areas** of society. The project focuses on '**open inquiry approaches'** as a major teaching target and pays much attention to both intrinsic and extrinsic **motivation of students** in the learning of science. The intended outcome is school science teaching becoming more **meaningful**, related to **21st century science** and incorporating **interdisciplinary socio-scientific issues** and **IBSE-related teaching**, taking particular note of **gender factors**.
Website and publications	PROFILES project

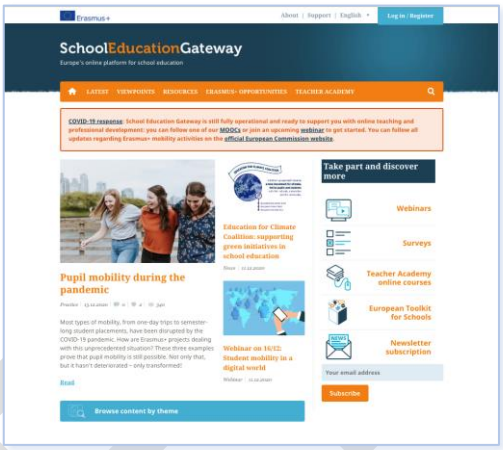
Sana Ment (Healthy Mind)

Selection criteria	**Students' centred and systemic approaches** · **Research** · **Innovation** · **Collaboration** · **Inclusivity** · **Career pathways** · **Critical thinking** · **Change** · **Evaluation** · **Potential to scale/spread innovations**
Leading organization	Living Lab for Health at IrsiCaixa in collaboration with Obra Social "la Caixa" and the European funded project EnRRICH
Target audience	Secondary school students
Topics	• Health • Science research
Format	☐Project ☑Practice
Digital proof	Multimedia content describing the face-to-face activity available online
Description and inspiring factors	Sana Ment is an example of a research practice conducted in collaboration with educators, students, researchers, patient associations and policy makers developed within the Xplore Health project in collaboration with the EnRRICH project. It aims to design and implement health interventions **for and with students**, involving them in **research** and **innovation** projects. The methodologies follow the RRI quality criteria and are inspired both by the model of Science Shops and Living Labs, promoted at European level, where methodologies such as community-based participatory research (CBPR), open innovation and participatory governance are applied. At the start of the project, the students conducted an analysis of their needs. They chose the topic of stress and depression from a list of health topics and collectively prioritised their main interests. In the second phase, various projects were designed and implemented with the collaboration of researchers, higher education students, secondary school pupils and teachers. The results were presented in a final congress at a local museum called CosmoCaixa, where students presented the results obtained and concluded the project with the **co-creation** of a final collective product. This product consisted on a Decalogue of recommendations (only available in Catalan) on how to promote emotional well-being. These recommendations were defined jointly with the participation of policy makers and patients' associations. The Sana Ment (Healthy mind) project counted with the collaboration of a total of 15 pilot schools in Catalonia and four research centres from different fields.
Website and publications	Sana Ment (Healthy Mind)



School Education Gateway

Selection criteria	Students' centred and systemic approaches; Research; Innovation; Collaboration; Inclusivity; Career pathways; Critical thinking; Change; Evaluation; Potential to scale/spread innovations
Leading organization	Steered by the European Commission (EC), implemented by its Education, Audiovisual and Culture Executive Agency (EACEA) and funded by Erasmus+.It is operated by European Schoolnet.
Target audience	Teachers, school leaders, researchers, teacher educators, policy makers and other professionals working in school education
Topics	• Science • Technology • Engineering • Mathematics
Format	☑Project ☐Practice
Digital proof	European online platform for school
Description and inspiring factors	Presented in 23 European languages, the School Education Gateway is an online platform for teachers, school leaders, researchers, teacher educators, policymakers and other professionals working in school education – including Early Childhood Education and Care (ECEC) and Vocational Education and Training (VET). This platform provides publications, tutorials and teaching materials to stay informed and to enhance pedagogical practice. It offers Erasmus+ resources for schools, such as a course catalogues, mobility opportunities, strategic partnerships and the resulting co-created resources, which can be used as benchmarks for teachers who wish to implement similar projects, or as tools for inspiration.
Website and publications	School Education Gateway

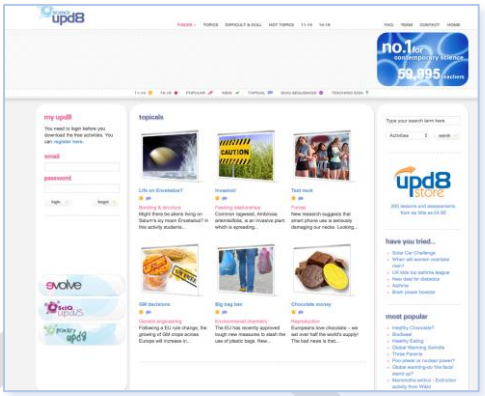


SCHOOLAB Innovation Studio

Selection criteria	**Students' centred and systemic approaches** · **Research** · **Innovation** · **Collaboration** · **Inclusivity** · **Career pathways** · **Critical thinking** · **Change** · **Evaluation** · **Potential to scale/spread innovations**
Leading organization	Schoolab & Co
Target audience	Corporations, startups, students and experts.
Topics	The • Innovation • Enterpreneurship • Design Thinking • Learning by doing
Format	☑Project ☐Practice
Digital proof	The activities combine both face-to-face and online implementation
Description and inspiring factors	Over the past 15 years, Schoolab has created a diverse community and network, connecting people and organizations. From Paris to San Francisco, they bring together entrepreneurs, executives, students and innovation experts. They design spaces and programs that allow differences within people and organizations to arise as an asset and create value. They have already created the largest innovation community in Europe including 5,000 innovators and creators of all ages, backgrounds, professions and horizon. They offer Schoolab programs for students and incubate startups. The aim of their action is to reveal individuals/talents and give them the keys to (re)invent their company, startup, association, institution. Their methods have shown outstanding results and the success of our projects are carried out by their clients around the world. This company offers training in **Design Thinking**, Lean Startup, **Open Innovation** and Prototyping and practices as **Hackathons, Innovation workshops** and Team Building strategies. In this project it is highlighted the creation of **Innovation Labs**, -also known as hubs, incubators, or accelerators— that are business units that employ the methods of agile startups, with the goal of devising novel ideas that can either disrupt or complement the overall company.
Website and publications	Schoolab

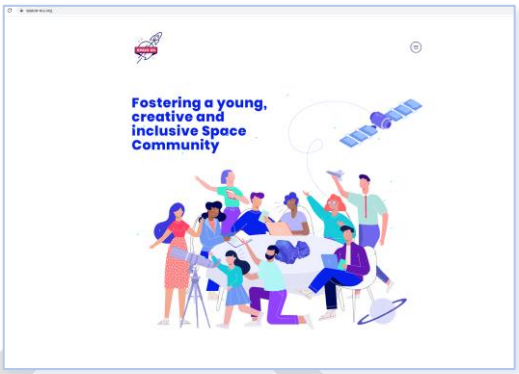
SCIENCE UPD8

Selection criteria	**Students' centred and systemic approaches** · **Research** · **Innovation** · **Collaboration** · **Inclusivity** · **Career pathways** · **Critical thinking** · **Change** · **Evaluation** · **Potential to scale/spread innovations**
Leading organization	Mastery Science. Produced by the Association for Science Education (ASE) and the Centre for Science Education at Sheffield Hallam University
Target audience	Primary and Secondary School
Topics	• Science • Biology • Chemistry • Working scientifically • Physics
Format	☐Project ☑Practice
Digital proof	Register is required but all materials are free and can be downloaded from the website
Description and inspiring factors	Science UPD8 is a repository of open educational resources based on contemporary issues helping to make science accessible, relevant and engaging to school students. It is a collection of science-in-the-news curriculum materials that includes scientists' comments, video clips and documentaries. It is designed for students to discuss about topical socio-scientific issues using science. Most teachers in the UK used upd8, and there were 50,000+ subscribers worldwide. Activities offer the opportunity to assess pupils' understanding and application of concepts, their problem solving, and team working and communication skills.
Website and publications	Science UPD8



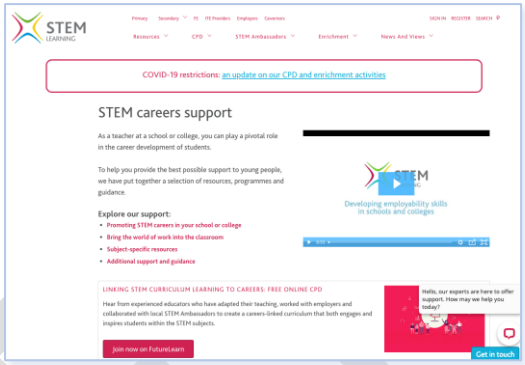
SpaceEU

Selection criteria	Students' centred and systemic approaches; **Research**; Innovation; Collaboration; Inclusivity; Career pathways; **Critical thinking**; Change; Evaluation; Potential to scale/spread innovations
Leading organization	Leiden University (funded by H2020)
Target audience	Education authorities, general public, industry, parents, policy makers, primary school students, researchers, secondary school students, teachers, trainee teachers and youth clubs.
Topics	• Astronomy • Environmental sciences • Gender in STEAM
Format	☑Project ☐Practice
Digital proof	Suitable for both online and face-to-face implementation
Description and inspiring factors	SpaceEU is a project that implements aSpace Outreach and Education programme to motivate and encourage young people to choose space-related careers. SpaceEU uses the perspective of space and the Universe to inspire and broaden young people's minds, develop a sense of European and global citizenship and build long-term partnerships among people from different cultural backgrounds and countries. The goal is to engage the target audiences of this project with **space science and careers**. The spaceEU **public engagement** programme represent opportunities for young people, their families and the general public to engage with government/policy makers/scientists and to explore topics like space exploration, exploitation of minerals in the solar system or space careers. SpaceEU will produce a new Impact Evaluation Toolkit which will combine the project findings with a baseline dataset of scientific interest on literacy and career awareness which will help provide universities and researchers with the tools and skills to make informed decisions and choices in this research area in the future. The project offers educational resources with special focus on **girls and underserved communities**. The project offers training programmes focusing on space education, space content, and promotion of space-related career paths, including yearly summer schools. The toolkit includes Gender and Equity Guidelines to consider when events related with engagement are organized.
Website and publications	Space EU SPACE EU Toolkit



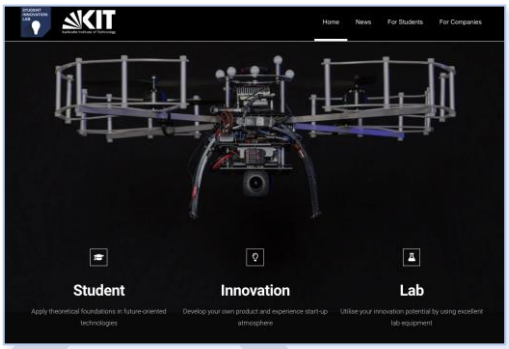
STEM Learning Network

Selection criteria	**Students' centred and systemic approaches** · Research · Innovation · **Collaboration** · Inclusivity · **Career pathways** · Critical thinking · **Change** · **Evaluation** · **Potential to scale/spread innovations**
Leading organization	National STEM Learning Centre in collaboration with UK Government
Target audience	School or college teachers
Topics	• Science • Technology • Engineering • Mathematics
Format	☐Project ☑Practice
Digital proof	Online training courses and resources
Description and inspiring factors	STEAM Learning is a platform to help teachers provide the best possible support to young people. It offers a selection of resources, programmes and guidance. It delivers teacher **continuing professional development** (CPD) in STEM subjects, it brings STEM role models into schools as part of the STEM Ambassador Programme or it provides long-term support for groups of schools in collaboration with companies through ENTHUSE Partnerships. The STEAM Learning Network comprises the National STEM Learning Centre, Science Learning Partnerships, STEM Ambassador hubs and computing hubs. The impact that the learning programmes have on teachers, support staff, technicians, STEM Ambassadors, employers and young people is evaluated.
Website and publications	STEM Learning Network



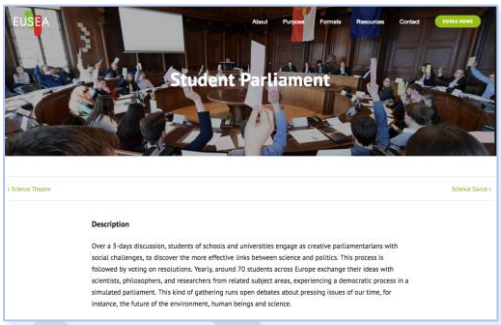
Student Innovation Lab (SIL)

Selection criteria	**Students' centred and systemic approaches** · **Research** · **Innovation** · **Collaboration** · **Inclusivity** · **Career pathways** · **Critical thinking** · **Change** · **Evaluation** · **Potential to scale/spread innovations**
Leading organization	Karlsruher Institut für Technologie (KIT)
Target audience	Master students of Electrical Engineering, Economics Engineering, Economics Science, Information Technology, Mechatronics and Computer Science.
Topics	• Entrepreneurship • Drones for innovative automation solutions • Mobile robot platforms • Robotics • Artificial intelligence
Format	☐Project ☑Practice
Digital proof	Online implementation: Lectures and teamwork are supported in virtual environments such as Zoom/Teams and available for registered students
Description and inspiring factors	The **student innovation labs** aim to promote sustainable and socially responsible growth by raising bottom up innovation capacity. The Student Innovation Lab 20/21 powered by KIT starts every course the week before the winter term with a Kickoff event. The module extends over 2 semesters with an expenditure of 15 ECTS. During the first semester students attend the lectures "**Entrepreneurship**" and "Agile System Development". A seminar and the practical applications in the innovation lab will take place during both semesters. The course finally concludes in a pitch at the end of the summer term. The lecture Entrepreneurship conveys theoretical foundations as well as application-oriented competences of innovation management and agile system development methods. Theoretical foundations are applied in a practice-oriented seminar and in different labs: Automation, Industry 4.0 and Interconnected Intelligent Systems. After choosing one of three labs the student develops an idea based on the provided technologies as a team. The course ends in a final pitch in front of investors. In addition, there are technical presentations from company representatives to give students insights in their daily work. Excursions to companies are also planned for the purpose of supporting the ideation process.
Website and publications	Student Innovation Lab



Student parliament

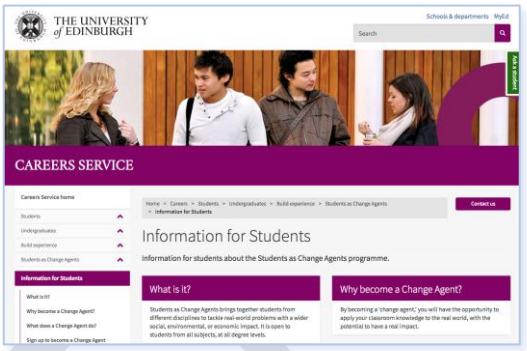
Selection criteria	**Students' centred and systemic approaches** · **Research** · **Innovation** · **Collaboration** · **Inclusivity** · **Career pathways** · **Critical thinking** · **Change** · **Evaluation** · **Potential to scale/spread innovations**
Leading organization	EUSEA Science Engagement Platform
Target audience	Students of schools and universities
Topics	• Science-related issues • Future of the environment • Future of human beings



Format	☐Project ☑Practice
Digital proof	These activities were organised face-to-face but they could be implemented online
Description and inspiring factors	The EUSEA Science Engagement Platform was established to serve **public engagement** professionals across Europe in their needs to find inspiration, resources, methods and tools for running participatory, dialogue-oriented engagement activities. Their platform unites and showcases inspiring and innovative ways to engage different publics with science. A special focus of the examples focus on **actively involving citizens** and stakeholders in **research** and **innovation** processes. It also has a clear goal to inspire and empower young Europeans to be open-minded, tolerant and active citizens. One of the activities they organise is 'Student Parliament'. Over a 3-days discussion, school students and universities engage as creative parliamentarians with social challenges, to discover the more effective links between science and politics. Then they vote on resolutions. Yearly, around 70 students across Europe exchange their ideas with scientists, philosophers, and researchers from related subject areas, experiencing a democratic process in a simulated parliament. This kind of gathering runs open debates about pressing issues of our time, for instance, the future of the environment, human beings and science. Students get trained and meet experts to know the pressing issues on a determined topic, acquiring knowledge about a specific theme. They take a standing point that will be presented with **argumentation**. The try to propose resolutions and defend these resolutions in a parliamentary debate. Afterwards, they hand them over to local and European policymakers for better decision-making, towards the issues that are currently concerning the population.
Website and publications	Student Parliament

Students as Change Agents

Selection criteria	**Students' centred and systemic approaches** · **Research** · **Innovation** · **Collaboration** · **Inclusivity** · **Career pathways** · **Critical thinking** · **Change** · **Evaluation** · **Potential to scale/spread innovations**
Leading organization	The University of Edinburgh
Target audience	Undergraduate students
Topics	Challenged tackled so far: • Ending violence against children • Gender financial equality • Circular economy • Healthy ageing in communities • Designing out waste in the construction industry • Aligning fintech firms with the UN's Sustainable Development goals • Reducing Youth Homelessness in Scotland • Environmentally sustainable revival of the Scottish tourism industry post-Covid
Format	☐Project ☑Practice
Digital proof	Online version is available for students through Microsoft Teams. Resources are delivered live with a facilitator but recordings can be accessed online
Description and inspiring factors	"Students as Change Agents" brings together students from different disciplines to tackle real-world problems with a wider social, environmental, or economic impact. It is open to students from all subjects, at all degree levels. By becoming a **change agent**, the student will have the opportunity to apply classroom knowledge to the real world, with the potential to have a real impact. The programme provides training in key skills such as problem solving, using data to solve problems, team work and pitching ideas. Change Agents work in small groups with other students, staff and external organisations to tackle complex challenges. These challenges have a major impact on society, the environment or the economy, have no simple solutions and cannot be addressed in isolation. Each challenge addresses at least 3 of the United Nations' Sustainable Development Goals. They are posed by organisations that are keen for **innovative thinking** from students who want to collaborate with each other and with them to make a difference.
Website and publications	Students as Change agents program



XPLORE HEALTH

Selection criteria	**Students' centred and systemic approaches** · **Research** · **Innovation** · **Collaboration** · **Inclusivity** · **Career pathways** · **Critical thinking** · **Change** · **Evaluation** · **Potential to scale/spread innovations**
Leading organization	Promoted jointly by IrsiCaixa and Obra Social "la Caixa"
Target audience	Secondary school students
Topics	• Drug research (drug development, vaccines) • Biotechnology • Genetics • Health (obesity, skin cancer, AIDS, malaria, mental health)
Format	☑Project ☐Practice
Digital proof	Multimedia resources can be used online. Teaching guides and card games are intended to be implemented face-to-face, but they can easily be adapted for online implementation
Description and inspiring factors	Xplore Health is a European educational programme offering interactive multimedia resources and didactic materials so that secondary schools can gain an insight into the latest biomedical research and consider the bioethical implications of the research. The programme encourages educational innovation through **Inquiry-Based Science Education** (IBSE), **Project-Based Learning** (PBL), **Group Dynamics** and **Formative Evaluation**. Competence-based learning is emphasized rather than learning contents. At the same time, it encourages **interaction** between students and other social actors, so that they can participate as responsible citizens in a knowledge-based society. In this type of interaction, for example, they are encouraged to interview researchers and entrepreneurs and to report the results of their projects to researchers, journalists, policy makers and the public. Xplore Health offers a variety of multimedia resources: (1) videos (introductory and on research projects) and online games, (2) virtual experiments and experimental protocols, that give students the opportunity to conduct experiments, either online or in laboratories, based on current lines of research, following protocols and using instruments like in real laboratories; (3) decide videos and card games to encourage **reflection** on ethical, legal and social aspects (ELSA) of research; (4) worksheets for pupils and guidelines for teachers that offer different learning contexts and pathways with a problem-based learning approach, in the context of which students use the resources described above; (5) **community-based participatory research projects** (CBPR), where students are invited to conduct research, acting as co-investigators with master students and **collaborating** with different social actors to contribute to solving a societal challenges In one modality students are encouraged to conduct participatory **research** projects in **collaboration** with different social actors in order to develop policy recommendations to improve health promotion. One of the projects of this type is entitled *Sana ment* (Healthy Mind).
Website and publications	Xplore Health Xplore Health (youtube channel)

2.2. Other inspiring practices

CIMULACT (Citizen and Multi Actor Consultation)	
Selection criteria	**Students' centred and systemic approaches** · **Research** · **Innovation** · **Collaboration** · **Inclusivity** · **Career pathways** · **Critical thinking** · **Change** · **Evaluation** · **Potential to scale/spread innovations**
Leading organization	29 European Consortium members coordinated by the Danish Board of Technology Foundation (Denmark)
Target audience	Citizens, scientists, policy makers and stakeholders
Topics	• Science • Technology • Innovation
Format	☑Project ☐Practice
Digital proof	Metodologies for online consultations
Description and inspiring factors	CIMULACT was an EC funded project that aimed to engage citizens and stakeholders in the **co-creation** of European **research agendas** based on real, validated and shared visions, needs and demands. CIMULACT established a genuine dialogue between citizens, stakeholders, scientists, and policymakers where visions and scenarios for desirable and sustainable futures were developed, debated and transformed into recommendations and suggestions for research and innovation policies and topics. More than 1,000 citizens in 29 countries in Europe formulated their visions and transformed it into 23 suggestions for Horizon 2020 topics along with policy recommendations. The results were afterwards validated, enriched and prioritised by more than 3,400 people consulted online. CIMULACT developed and experimented with methods for **citizen participation** on long-term foresight. It also developed capacities in already existing methods. The experiments explored a variety of methods in order to test and inspire the research community with a broad range of options for citizen and multi-actor engagement in research and innovation priority setting. Furthermore, the diversity of methods also allowed targeting **different societal groups**, enriching the feedback and validation of the research programme scenarios from a wide range of societal perspectives. Those methodologies can also be inspiring to engage students.
Website and publications	CIMULACT

RiConfigure: The Social Lab Methodology Manual

Selection criteria	**Students' centred and systemic approaches** · **Research** · **Innovation** · **Collaboration** · **Inclusivity** · **Career pathways** · **Critical thinking** · **Change** · **Evaluation** · **Potential to scale/spread innovations**
Leading organization	RiConfigure Consortium coordinated by the Danish Board of Technology Foundation. Project funded by European Comission (EC).
Target audience	Industry, academic research, public sector, civil society
Topics	• Innovation • Collaboration • Co-creation • Stakeholders
Format	☐Project ☑Practice
Digital proof	The document provides guidelines to facilitate face-to-face sessions, although they could be adapted to be used online.
Description and inspiring factors	The Social Lab Methodology Manual is an initiative of the EU Horizon 2020 funded project RiConfigure which aims to open the innovation process, not only to the industry, the public sector and research, but also to civil society. Bringing different voices together in new types of collaborations avoids blind spots because every actor has specific competences and focus points. The project exists to include more diverse voices to the innovation process to find more holistic solutions that could not have been developed without the active co-creation of civil society. The Manual provides information for designing and implementing social labs in the context of **collaborations between four types of stakeholders**: science, industry, citizens and government. The term 'social lab' stands for a set of activities by which stakeholders tackle together a complex problem and learn from how others have struggled with similar problems. It offers a set of **collaborative methodologies** such as **stakeholder mapping**, **collaborative storytelling**, **evaluation gaming** or **visioning sessions very useful** when bringing together a wide variety of stakeholders and when stablishing collaborations. Social labs could also be established in schools who could promote open innovation processes, or, if they are already created by other stakeholders, they could be asked to engage students in their processes.
Website and publications	Social Lab Methodology Manual

3. Conclusions

The 10 selection criteria defined during the development of this catalogue are useful to identify inspiring resources, and therefore they can constitute a useful tool to design innovative educational resources for Open Schooling.

Some of these selection criteria include examples of methodologies and pedagogical approaches that can be used which have been identified within innovative policy frameworks for research and innovation, such as Responsible Research and Innovation, Open Science, Open Innovation and even Mission Oriented Research. Therefore, these innovative approaches to the way R&I are performed can be inspiring frameworks for Open Schooling.

Although some of the resources selected are clear examples of one single selection criteria, most of them actually fit in several of them, which gives light to innovate in Open Schooling resources by focusing in combining several of those criteria to improve the success ratios in promoting science capital among students. During the CONNECT project those innovative approaches to Open Schooling will be explored, innovative educational resources will be developed and their effectiveness will be evaluated to be able to conclude with recommendations for Open Schooling based on evidence.

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Annex. Glossary

AR inquiry games

AR inquiry-based games are innovative digital games that combine a fictional world and real objects or spaces to create a game scenario where players are immersed and interact through augmented reality displays to investigate socio-scientific questions. AR inquiry-based games aim to engage students in real-life scenarios and contribute to stimulate their curiosity for research and apply science knowledge to make decisions. (Cavanaugh, 2008; Okada, 2019).

Citizen science (CS)

In Citizen science research is performed with the involvement of the public– including both community-driven research and global initiatives. The Citizen Science Association unites expertise from educators, scientists, data managers, and other stakeholders to promote citizen science to help speed innovation in this field by sharing insights across disciplines. Other examples of citizen science can be found in the US Citizen Science portal ("CitizenScience.gov", 2020; "Citizen Science: partnering the public and professional scientists.", 2020)

Citizen juries

A **Citizens Jury** is a methodology of deliberation that normally involves around 12-24 randomly selected citizens (through stratified random sampling) representative of the demographics of the area. According to the Jefferson Centre, which designed the method, a citizens jury should take place over 4-7 days. However, most juries are held over 2 days. Citizens juries are suitable for engaging citizens in a range of issues, such as examining cuts in public service funding, balancing work and family life or improving healthcare provision. They are relatively inexpensive compared to larger deliberative exercises and their small size allows for effective deliberation: they are sufficiently diverse and citizens are exposed to a wide range of perspectives ("Citizen Science: partnering the public and professional scientists.", 2020).

Co-creation

A conceptualization of **co-creation** is occupying the space in between student engagement and partner-ship, to suggest a meaningful collaboration between students and other stakeholders, with students becoming more active participants in the learning process, constructing understanding and resources with academic staff. (Bovill et al., 2016)

Community-Based Participatory Research (CBPR)

Community-based participatory research (CBPR) is a partnership approach to research that equitably involves community members, organizational representatives, researchers, and others in all aspects of the research process, with all partners in the process contributing expertise and sharing in the decision-making and ownership. The aim of CBPR is to increase knowledge and understanding of a given phenomenon and to integrate the knowledge gained with interventions for policy or social change benefiting the community members. (Israel et al., 1998)

Competency-based learning (CBL)

Competency-based learning refers to systems of instruction, assessment, grading, and academic reporting that are based on students demonstrating that they have learned the knowledge and skills they are expected to learn as they progress through their education. CB systems use state learning standards to determine the level of achievement of academic expectations and define “competency” or “proficiency” in a given course, subject area, or grade level. The aim of CBL is to ensure that students are acquiring the knowledge and skills that are essential to succeed in school, higher education, careers, and adult life as opposed to more traditional educational approaches in which students can get promoted to the next grade level even if they don’t acquire proficiency. ("Competency-Based Learning Definition", 2020)

Cooperative learning (CL)

Cooperative learning is the instructional use of small groups where students work together to maximize their own and each other’s learning. In every classroom, instructional activities are aimed at accomplishing goals and are conducted under a goal structure. A learning goal is a desired future state of demonstrating competence or mastery in the subject area being studied. The goal structure specifies the ways in which students will interact with each other and the teacher during the instructional session. ("What is Cooperative Learning? — Cooperative Learning Institute", 2020)

Design thinking (DT)

Design Thinking is a mind-set and approach to learning, collaboration, and problem solving. In practice, the design process is a structured framework for identifying challenges, gathering information, generating potential solutions, refining ideas, and testing solutions. Design Thinking can be flexibly implemented; serving equally well as a framework for a course design or a roadmap for an activity or group project. ("Design Thinking in Education", 2020)

Do it yourself (DIY)

Do it yourself (DIY) is the method of building, modifying, or repairing things without the direct aid of experts or professionals. Recently, the term DIY has taken on a broader meaning that covers a wide range of skill sets. DIY has been described as a "self-made-culture" by which individuals design, create, customize and repair items or things without any special training. DIY has grown to become a social concept with people sharing ideas, designs, techniques, methods and finished projects with one another either online or in person. ("Do it yourself", 2020)

Gamification

Gamification is the use of game mechanics, dynamics, and frameworks to promote motivation and enhance engagement among students. (Lee, J.&Hammer, J.,2011)

Hackathons

The **hackathon** is a hands-on, solution-based development model with similarities to Problem Based Learning, inquiry-based learning, STEAM, and design thinking by which students use their skills and knowledge to solve problems. It is project-based learning combined with inquiry-based learning, system thinking and STEM, all wrapped up into one activity. In hackathons, students work collaboratively within mixed-ability groups to

examine problems and come up with solutions. ("Hackathons as a New Pedagogy", 2020)

Home-related science

Home-related science is referred to practices which are carried out in the homes where children live, many of which have some scientific and technological implications that will fast track the teaching and learning of school science and technology. Ahiakwo (2006) called them home sciences that are students‘ construct which come from their homes and environmental experiences. (Obomanu & Akporehwe, 2012)

Inquiry Based Science Education (IBSE)

Inquiry Based Science Education (IBSE) is a form of science education by which students act like scientists to discover science laws. This approach gives students the opportunity to explore “hands on”, to experiment, to ask questions and to develop responses based on reasoning unlike the traditional model where the teacher provides facts and the students learn them. ("THE MEANING OF AND NEED FOR “INQUIRY BASED SCIENCE EDUCATION (IBSE)”", 2020)

Inquiry workflow

Inquiry workflow is a pedagogical approach for students to be implemented together with teachers and scientists which consists on using smart support tools for facilitating scientific inquiry as an approach for science learning and teaching combined with curricular content and other teaching practices. Students can create and adapt inquiry workflows to help them investigate socio-scientific issues and develop research supported by digital technologies. This approach can be supported by a **collaborative** cloud-based environment, which enables projects to be implemented within global and local scenarios. The platform can also support learning through **evaluation** through self-assessment and peer-evaluation and/or spaces for interacting with scientists and other stakeholders. By doing collaborative research through inquiry workflow students more easily play the role of explorers and scientists, promoting their curiosity, self-reflection skills and knowledge acquisition. (Okada, 2013)

Inquiry games

Inquiry games are computer-based resources for IBSE game-based learning. These educational games can be offered through virtual learning environments on mobile apps developed for learning contexts. (*Using game-based inquiry learning to meet the changing directions of science education*, 2011)

Open innovation

Open Innovation is a term coined by Chesbrough (2003) that can be defined as the combination of internal and external ideas as well as internal and external paths to market to advance the development of new technologies. ("Open Innovation", 2020)

Open schooling

Collaborative projects focused on real-life challenges and innovations, including associated ethical,social and economic issues, which are addressed inpartnerships among teachers, local communities, enterprises and families. The European Commission report Science Education for Responsible Citizenship (Ryan, 2015) highlighted this approach as it bridges formal, non-formal and informal learning to ensure relevant participation and meaningful engagement of society with science. It aims to

motivate students to learn science and promote science careers among students. ("Open Science Schooling – Open Science Schooling", 2020)

Open science (OS)

Open science can be defined as the practice of science in such a way that others can collaborate and contribute, where research data, lab notes and other research processes are freely available, under terms that enable reuse, redistribution and reproduction of the research and its underlying data and methods. ("Adapt", 2020)

Participatory Action Research (PAR)

Participatory Action Research (PAR) is an approach to enquiry, which has been used since the 1940s. It involves researchers and participants working together to understand a problematic situation and change it for the better. PAR focuses on social change that promotes democracy and challenges inequality; is context-specific, often targeted on the needs of a particular group. It follows an iterative cycle of research, action and reflection, and often seeks to create awareness among participants of their particular situation in order to take action. (Macbeth, 2020; Baum, F., MacDougall, C., & Smith, D., 2006).

Participatory democracy

Participatory democracy is a model of democracy in which citizens have the power to decide directly on policy and politicians are responsible for implementing those policy decisions. In a participatory democracy, citizens can influence policy decisions, but do not make them. Politicians are still responsible for implementing those policy decisions. Scientific parliaments and citizen juries are methodologies for participatory democracy. (*Types of democracy*, 2020; Biegelbauer, Peter & Hansen, Janus., 2011).

Problem-Based Learning (PBL)

Problem-Based learning (PBL) is an active learning methodology by which the teacher poses a real problem to the students and helps them to investigate the answer by letting them find the solution themselves. PBL is based on real situations, either problems, questions or scenarios as a starting point and follows a defined, summative, progressive process that once completed can start again with new questions generated during its development, contributing to knowledge acquisition about a subject and development of open-ended problem solving skills. ("Problem-Based Learning (PBL) - Blended teaching (UPF)", 2020)

Public engagement

The National Co-ordinating Centre for Public Engagement (NCCPE) defines **public engagement** as the myriad of ways in which the activity and benefits of higher education and research can be shared with the public. Engagement is by definition a two-way process, involving interaction and listening, with the goal of generating mutual benefit. Benefits might include learning, developing new skills, gaining new insights or ideas, developing better research, raising aspiration, or being inspired. ("What is public engagement? | NCCPE", 2020)

Responsible Research and Innovation (RRI)

Responsible Research and Innovation (RRI) is an approach that anticipates and assesses potential implications and societal expectations with regard to research and innovation, with the aim to foster the design of inclusive and sustainable research and innovation. RRI implies that societal actors (researchers, citizens, policy makers,

business, third sector organisations, etc.) work together during the whole research and innovation process in order to better align both the process and its outcomes with the values, needs and expectations of society. ("Responsible research & innovation - Horizon 2020 - European Commission", n.d.; "About RRI - RRI Tools", 2020).

Science-action

A **science-action** is a problem-solving activity where students learn science knowledge, skills and attitudes to tackle a future-oriented socio-scientific issue. Students then apply them by implementing actions in collaboration with scientists, families and other stakeholders to benefit their lives, their community and society.

Science capital

The concept of **science capital** can be imagined like a 'holdall', or bag, containing all the science-related knowledge, attitudes, experiences and resources that you acquire through life. It includes what science you know, how you think about science (your attitudes and dispositions), who you know (e.g. if your parents are very interested in science) and what sort of everyday engagement you have with science. The concept of science capital is drawn from the sociologist Pierre Bourdieu's concept of capital (referring to economic, cultural and social resources) – in short, Bourdieu proposes that the more you have of the 'right sort' of capital, the better you are able to 'get on' in life. (*Science capital made clear*, 2016)

Science Education (SE)

Science Education is the teaching and learning of science to non-scientists, such as school children, college students, or adults within the general public. The field of science education includes work in science content, science process (the scientific method), some social science, and some teaching pedagogy. The standards for science education provide expectations for the development of understanding for students through the entire course of their K-12 education and beyond. The traditional subjects included in the standards are physical, life, earth, space, and human sciences. ("Science education", 2020)

Science Shop

Science shops are small entities that carry out scientific research in a wide range of disciplines –usually free of charge and- on behalf of citizens and local civil society. Science shops respond to civil society's needs for expertise and knowledge, a key element that distinguishes a science shop from other knowledge transfer mechanisms. A Science Shop provides independent, participatory research support in response to concerns experienced by civil society. Sometimes the research is performed by students ("About Science Shops", n.d.).

Scientific parliaments

Scientific parliaments are participatory democracy spaces to promote dialogue between parliamentarians, scientists and the rest of society to foster better governance of Science, Technology and Innovation (STI) systems.
Good governance of STI requires a holistic approach with the participation and inclusion of all members of society in the policy process. Participation and engagement of all key stakeholders, including decision makers, women, youth, the media, academia, research institutes, public and private sector, and civil society in science governance processes

foster better governance of STI and create sustainable societies. ("STI Policy: The Role of Parliaments | United Nations Educational, Scientific and Cultural Organization", 2017)

Service learning

Service-learning is an educational approach that combines learning objectives with community service in order to provide a progressive learning experience while meeting societal needs. Service learning involves students in service projects to apply classroom learning for local agencies that exist to effect positive change in the community. (*K-12 Service-learning Standards for Quality Practice*, 2009)

STEAM education

STEAM is the acronym of Science, Technology, Engineering, Arts and Mathematics. The Founder of the STEAM Educational Movement 2006, CEO Georgette Yakman, defined STEAM as "Science & Technology, interpreted through Engineering & the Arts, all based in Mathematical elements." Therefore, STEAM Education is an approach to learning that uses Science, Technology, Engineering, the Arts and Mathematics as access points for guiding student inquiry, dialogue, and critical thinking. ("STEAM Education", 2006)

Student-centred learning (SCL)

Student-centred learning is an approach to education which aims to overcom some of the problems inherent to more traditional forms of education by focusing on the learner and their needs, rather than being centred on the teacher's input. Knowledge is constructed by students, whereas teachers act as facilitators. This approach has many implications for the design and flexibility of the curriculum and the course content, and interactivity of the learning process, contributing to an empowerment of learners to enhance the educational process. (*Student-centred learning: what does it mean for students and lecturers?*, 2005)

System Thinking (ST)

System Thinking is an approach advocating thinking about any given issue as a whole, emphasising the interrelationships between its components rather than the components themselves (Shaked, Haim & Schechter, Chen., 2013). Therefore, it usually requires transdisciplinary and participatory approaches.

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