



Grounding RRI Actions to Achieve Institutional Change in European Research Funding
and Performing Organisations

Grant Agreement n. 824521

STATE-OF-THE-ART REVIEW OF DOCUMENTED EXPERIENCES

*Document 3 – Collection of experiences in
science education*

Prepared by



May 2019





Disclaimer

The sole responsibility for the content of this publication lies with the authors. It does not necessarily reflect the opinion of the European Commission. The European Commission is not responsible for any use that may be made of the information contained therein.

Copyright

This document may not be copied, reproduced, or modified in whole or in part for any purpose without written permission from the GRACE Consortium. In addition, an acknowledgement of the authors of the document and all applicable portions of the copyright notice must be clearly referenced.

All rights reserved.

This document may change without notice.



Table of contents

Introduction	4
This document	4
SECTION ONE – SCIENCE EDUCATION WITH AND FOR SCHOOLS	6
1. The issue.....	7
2. Examples of action	7
3. To know more	9
SECTION TWO – SCIENCE OUTREACH	10
1. The issue.....	11
2. Examples of action	11
3. To know more.....	12
SECTION THREE – INTERNAL SKILLS IN SCIENCE EDUCATION.....	14
1. The issue.....	15
2. Examples of action	15
3. To know more.....	15
SECTION FOUR – GOVERNANCE STRUCTURES ON SCIENCE EDUCATION.....	17
1. The issue.....	18
2. Examples of action	18
3. To know more	19



Introduction

In the framework of the Grounding RRI Actions to Achieve Institutional Change in European Research Funding and Performing Organisations (GRACE) project, under WP3 (Governance and Mutual Learning), a specific Task (T3.1) is focused on “the collection of experiences documenting RRI-documented institutional changes” and on “the elaboration of these experiences into a set of short guidance documents”.

The overall aim of the Task is that of **assisting the GRACE partners** engaged in embedding RRI in their own institute to design and implement a set of RRI-oriented Grounding Actions (GAs), to integrate these GAs with each other (developing a unitary governance system for them), to ensure their sustainability and to use them as a platform for developing a Roadmap towards RRI going beyond the GRACE project lifespan (overall 8 years).

In order to pursue this objective, a state-of-the-art of documented experiences on RRI has been developed, the results of which are presented in **seven autonomous documents**, although connected to each other, i.e.:

- Document 1 - Collection of experiences on gender equality
- Document 2 - Collection of experiences on citizen engagement
- Document 3 - Collection of experiences in science education
- Document 4 - Collection of experiences on research ethics and integrity
- Document 5 - Collection of experiences on open access
- Document 6 - Approaches to RRI implementation
- Document 7 - Basic scheme for self-assessment

All the documents have been developed by Knowledge & Innovation (K&I), which is the leader of WP3. In particular, this document has been developed by Luciano d’Andrea and Claudia Colonnello (K&I). They are not formal deliverables and their circulation is restricted to the GRACE project consortium members.

This document

This is the 3rd document of the series, devoted to the **experiences related to science education**. Its aim is helping GRACE partners reflect on possible GAs to develop in this area during the project implementation period or in the framework of the 8-year Roadmap towards RRI¹.

The overall aim of Science Education is to enhance education processes to attract and better equip future researchers and other societal actors with the necessary knowledge to fully responsibly join research and innovation processes. This also includes initiatives aimed at boosting science literacy in society and sparking the interest of children in science and technology.

This short document also considers education initiatives aimed at supporting the diffusion of RRI in higher education settings.

The document is organised in **four sections**, respectively devoted to:

¹ There are some overlaps between science education and citizen engagement for what concerns the activities aimed at promoting science literacy through science communication and those related to Citizen Science, which are presented in the document devoted to citizen engagement (the second of the series).



- Science education with and for schools
- Science education outreach
- Internal skills in science education and RRI
- Governance structures on science education.

The document has been developed by Luciano d'Andrea and Claudia Colonnello (K&I).



Section One – Science education with and for schools



1. The issue

The first area of action for Science Education is **establishing cooperation relationships between research organisations and schools**. Research organisations often play an active role in the promotion of science education programmes addressed to school students and teachers (certainly primary schools but mainly secondary schools), pursuing a **wide range of objectives**, including:

- Promoting a direct contact of students with the reality of the research organisation, on both the contents and practices of research (e.g., initiatives inside the Labs with pupils)
- Showing controversial issues attached to specific scientific areas
- Attracting youth (especially girls) to scientific careers
- Involving students in co-design initiatives so as to help them understand the logic of scientific discovery and innovation
- Building new aptitudes (critical thinking), multidisciplinary knowledge and collaborative learning skills
- Supporting schools teachers to introduce new approaches and methods in science teaching and learning.

2. Examples of action

Among the many possible kinds of action which can be promoted in the framework of the cooperation between research organisations and schools, four main strategies can be highlighted here:

- Involving schools in broad collaborative networks
- Fostering curricula innovation to make science teaching more attractive to students
- Integrating RRI in science education for secondary school students
- Supporting school teachers in updating and innovating their teaching methods and contents.

a. Involving schools in broad collaborative networks

A role research organisations may play for science education is that of contributing in the involvement of schools in large collaborative networks allowing them to be continuously stimulated in renovating methods and approaches and to keep links between formal education (i.e., the education provided by formally recognised educational institutions), non-formal education (i.e., the structured education provided by organisation different from the recognised educational institutions) and informal education (i.e., the educational experience which emerge as part of other activities such as, for example, those related to sports and hobbies).

In addition to research organisations, these networks may include, for example:

- Entrepreneurs, companies, and business associations
- Institutions like science centres, botanical gardens, or planetaria
- NGOs, foundations, and other civic institutions.

b. Fostering curricula innovation to make science teaching more attractive to students



A second strategy is aimed at innovating the way in which science is taught so as to **make science teaching more attractive to students**. Among the many activities which are usually proposed in this regard, the following can be mentioned as examples.

- Organising **outdoor education activities** allowing students, e.g., to know local ecosystems, to make direct observations of natural phenomena, or to see critical situations (for example, cases of pollution).
- Proposing **initiatives involving an interaction between students and researchers** so as to allow students, e.g., to work with scientists for a period of time, to dialogue with them on specific science topics in the framework of dialogue events (for example, science café), or to have an exchange with scientists about their professional and personal experience.
- Involving students with the support of scientists in **hands-on activities** such as, e.g., developing a poster presentation, conducting experiments, drafting a scientific article, writing a research proposal, collecting scientific information on the internet, or producing a video on scientific issues.

c. Integrating RRI in science teaching for secondary school students

This strategic line of action is aimed at integrating societal aspects of science and RRI in science curricula (in different scientific sectors) for secondary schools. Some examples of the possible actions which can be proposed are listed below.

- Introducing RRI at school through **project-and inquiry-based learning**, allowing students to face with questions, problems and challenges to be addressed through science and technology (for example, making an analysis of the problems in their cities and looking for solutions based on science and technology).
- Organising **workshops and meetings involving school teachers and students on RRI-related issues** (for example, ethical issues related to specific research fields, gender equality in scientific careers, public participation in science policies, etc.).
- Arranging **competitions and science quizzes on scientific issues and RRI's keys** (for example, socio-ethical controversial issues).

d. Supporting school teachers in updating and innovating their teaching methods and contents

Another important role potentially played by researchers and research organisations is that of helping school teachers updated and innovate their teaching methods and contents. Some examples of action are proposed below.

- Creating **networks and platforms involving both researchers and science teachers** (or promoting their participation in the existing ones) in order to exchange innovative teaching concepts and experiences in formal and informal learning programs and initiatives.
- Supporting school teachers in **revising their science didactic activities, plans and programmes**, for example, through exchange initiatives, workshops, or training modules.



- Establishing **cooperation agreements** involving research organisations and high school institutions aimed at updating and innovating teaching methods and contents.

3. To know more

Some resources focusing on initiatives and best practices of science education for schools are listed below.

- A teachers' Guide of including best practices in Science Education for secondary schools (ages 11-16)
https://sciencemarch.eu/images/sm-images/march_pilots_educational_toolkit.pdf
- A report developed by European Schoolnet providing an overview of the situation of STEM in European education systems.
http://www.scientix.eu/documents/10137/782005/Scientix_Texas-Instruments_STEM-policies-October-2018.pdf/d56db8e4-cef1-4480-a420-1107bae513d5
- The portal Open Schools for Open Societies in which several innovative projects concerning science teaching in schools are illustrated
<https://portal.opendiscoveryspace.eu/en/osos>)
- The booklet on the Socio-Scientific Inquiry-Based Learning developed under the PARRISE project
<https://www.parrise.eu/wp-content/uploads/2018/04/parrise-en-rgb.pdf>
- The TWIST teachers guide on gender awareness in science teaching
http://www.the-twist-project.eu/media/dyn/TWIST-Onze_size_fits_all.pdf
- [A Report developed by the European Commission on science education](http://ec.europa.eu/research/swafs/pdf/pub_science_education/KI-NA-26-893-EN-N.pdf)
http://ec.europa.eu/research/swafs/pdf/pub_science_education/KI-NA-26-893-EN-N.pdf



Section Two – Science outreach



1. The issue

The second area of action relevant for science education is **science outreach**. This concept is an “umbrella concept” including a wide range of activities united by the same basic idea of “bearing science” outside research environments.

Someone also considers science education activities carried out in schools as a form of science outreach. We preferred here to keep activities involving schools separate since they directly influence the way in which science is formally taught in the schools. Under the concept of science outreach, only activities of informal nature are labelled here as “science outreach”, usually aimed at reaching audiences usually excluded from formal education mechanisms (for different reasons, including forms of social exclusion grounded on class, gender, race, or age).

Types of outreach initiatives can be, for example:

- **Community events**, such as science festivals or science days in which, thanks to portable labs, exhibits and scientific demonstrations, it is possible to show scientific processes and results
- **Science contests**, allowing youth and other groups to get involved in scientific initiatives and to express their own creativity
- **Internships**, aiming people to make direct experience of the scientific work
- **Hands-on activities**, which allow participants to get involved in practical experiments and to better grasp the contents and implications of the issues dealt with by scientists
- **Debates** concerning science-related topics, which makes it possible to get aware of the role of science in dealing with societal challenges.

It is to be also noticed that, in many academic environments, **science education outreach is still considered something that “good scientists” have no time to do** and therefore reserved to those who are not fully committed with the scientific work. Overcoming this stereotypical view of science outreach is probably one of the main barriers to face in the pathway towards RRI.

2. Examples of action

With reference to this area, three main strategies can be identified which are not alternative with each other:

- Establishing permanent collaborations or promoting coalitions with external entities
- Directly promoting science education outreach programmes
- Developing web-based science education programmes.

a. Establishing permanent collaborations or promoting coalitions with external entities

The first strategy for a research organisation is that of **establishing collaboration agreements or participating in coalitions with external entities** with the aim of reaching specific target groups through outreach programmes.

Collaborations may involve, for example, science museums, science centres, zoos and botanic gardens, civil society organisations, industries, media, or local authorities. Moreover, collaborations may also involve science educationalists as well as formal, non-formal and informal education providers.



The advantages for a research organisation to work with other entities are many, including the access to consolidated expertise in science education, the opportunity to develop big outreach programmes with relatively limited investment or the possibility of being involved in the development of innovative approaches to science education by cooperating with other expert actors.

b. Directly promoting science education outreach programmes

A second possible strategy for research organisations is that of **directly promoting science education outreach programmes**.

In some cases, large research organisations have established a **permanent centre or structure** (for example, an Office of Science Outreach) aimed at developing outreach programmes and at supporting departments, faculties, or other internal units in creating and developing outreach ideas and proposals.

In other cases, a programme of initiatives is promoted **without creating specialised units or structures**. Typically, science outreach initiatives are combined with science communication initiatives (see document 2 on Citizen Engagement) such as the Researchers' night, Festivals of science or the University Open Day.

Outreach programmes can include many different kinds of initiatives, such as the organisation of training modules or courses open to external groups, public lectures series, dialogue initiatives, organisation of awards, competitions, and public events, exhibitions, or the development of science street activities (for example, lectures organised in public spaces like squares and metro stations), or science education outreach programmes involving rural communities or poor urban families.

Finally, in many cases outreach initiatives are promoted and conducted by **individual researchers or research groups**. They usually include, e.g., public presentations for non-scientist audiences, informal education initiatives, lab visits, field excursions, or lessons/lectures in the context of lifelong learning programmes.

c. Developing web-based science education programmes

A third strategy, which can be also combined with the previous two, is that of developing **web-based science education outreach programmes**.

In practical terms, most of the science education outreach activities can be delivered online, including, for example, lecturers and training modules, virtual lab visits, access to digital documents and materials, virtual games focusing on scientific issues, or educational videos. Also, interactive activities can be promoted on the Web.

3. To know more

Some sources addressing science outreach are provided below.

- A set of best practices on outreach and science education in the field of marine sciences [http://www.seachangeproject.eu/images/SEACHANGE/SC_Results//D3.4 Online Directory of Good Practice Final.pdf](http://www.seachangeproject.eu/images/SEACHANGE/SC_Results//D3.4_Online_Directory_of_Good_Practice_Final.pdf)



- The outreach programme developed by the Stanford's Office of Science Outreach (OSO) <https://oso.stanford.edu>, including a set of resources (<https://oso.stanford.edu/resources/faculty>)
- SciRech, an online database on science communication and outreach <https://www.scireach.org/>
- A toolkit on science communication and outreach developed under the EC-funded DESIRE project http://desire.eun.org/c/document_library/get_file?uuid=19f37a23-d566-4a49-8106-5a29857a16f3&groupId=12834



Section Three – Internal skills in science education



1. The issue

The third area of action for research organisations includes all the activities aimed at **improving the skills and competencies of researchers in science education**.

The core idea at the basis of this kind of actions is that scientists are not prepared, on the one side, to conduct science education activities and, on the other side, to develop research activities following RRI principles and practices. Hence the need for initiatives integrating science education and RRI in **university curricula** of researchers in the different research fields.

2. Examples of action

This kind of activities can develop through a wide range of tools and approaches. Some examples are listed below.

- **Training modules or course** aimed at integrating RRI and science education in Higher Education curricula; they may include both formal training modules or PhD courses and less structured and shorter training initiatives, such as workshops, seminars and lectures.
- New **university chairs** on science education and RRI-related issues.
- **Training for trainers** initiatives on science education or other RRI-keys (for example, gender equality in science, research ethics and integrity, or public engagement).
- **Online training initiatives** such as training courses or Massive Open Online Courses (MOOC) pertaining to science education or RRI.
- Permanent **consultancy services** aiming at supporting researchers and departments in science education and RRI-related training.
- **Websites and web-based platforms** on science education and RRI-related training.
- **Mapping of researchers, research units and relevant stakeholders** inside the research organisation already committed to science education.

3. To know more

There are not so many sources addressing the building of new competencies and skills in research organisations pertaining to science education and RRI-related training. Probably the most relevant resources can be those developed under the EC-funded HEIRRI and EnRRICH projects. In particular, the following sources can be particularly useful.

- The training programmes addressing RRI (HEIRRI)
<http://heirri.eu/resources/heirri-at-rritools-eu/>
- A document on how to design curricula in higher education from an RRI perspective (EnRRICH)
https://www.livingknowledge.org/fileadmin/Dateien-Living-Knowledge/Dokumente_Dateien/EnRRICH/D2.3_The_EnRRICH_Tool_for_Educators.pdf



- The document “Embedding Responsible Research and Innovation in Higher Education Curricula: Practical approaches” (EnRRICH)
https://www.livingknowledge.org/fileadmin/Dateien-Living-Knowledge/Dokumente_Dateien/EnRRICH/EnRRICH_Policy_Brief_D5.3.pdf
- An inventory of training experiences on RRI in higher education (EnRRICH)
http://www.guninetwork.org/files/images/imce/heirri_wp2_d2.3.pdf



Section Four – Governance structures on science education



1. The issue

The rapid changes affecting science-society relations, as they also emerge from RRI, are increasingly leading to a stronger involvement of research organisations serving as reference points in science education-related activities. As a matter of facts, scientists and research organisations are directly concerned with all the objectives pursued through science education (see the box below), even though they only rarely perceive science education as part of their own institutional role and mission.

OBJECTIVES OF SCIENCE EDUCATION

The Network of National Contact Points for Science with and for Society in Horizon 2020 (SIS net) developed a document containing a list of objectives for attaining which science education plays a key role. According to the document, science education is vital:

- To promote a culture of scientific thinking and inspire young people in using evidence-based reasoning for decision making, as opposed to values and reasoning processes that are less reliable or that are only based on beliefs or feelings
- To ensure citizens have the confidence, knowledge and skills to participate actively in an increasingly complex scientific and technological world
- To develop the competencies for problem-solving and innovation, as well as analytical and critical thinking that are necessary to empower citizens to lead personally fulfilling, socially responsible and professionally-engaged lives promoting solidarity at national, European and global level
- To inspire children and students of all ages and talents to aspire the careers in science and other occupations and professions that underpin our knowledge and innovation-intensive societies and economies and in which they can be creative and accomplished
- To enable public, private and third-sector organisations, based in Europe, to find appropriately skilled and knowledgeable people, and to promote and nurture an innovative Europe-wide environment where companies and other stakeholders from around the world want to invest, work and live
- To empower active and responsible participation in public science communication, debates and decision-making as active engagement of European citizens in the big challenges facing humanity today.

http://www.sisnetwork.eu/media/sisnet/Policy_Brief_Science_Education.pdf

In this framework, research organisations are increasingly asked to establish new governance structures allowing them to better organise and coordinate their engagement in science education.

2. Examples of action

This fourth area of action is mainly concerned with the creation of organisational structures devoted to science education. Although they largely vary, some recurrent ways to develop a governance structure can be noticed, including, e.g.:

- Establishing an **office of science education** (usually attached to the faculty of science), aimed at creating partnerships with external science education entities (science centres, science museums, etc.), supporting researchers and students in developing their capacities in science educations, and promoting direct science education initiatives
- Developing an **action plan** or **regular programmes** in science education, to be implemented by a dedicated team



- **Incorporating science education** as an area of action and responsibility in one or more existing structures, such as, for example, the units in charge of communication and public relations, of public engagement, or human resources
- Establishing **incentives, awards, protocols and guidelines** for encouraging researchers, research groups, and research departments to incorporate science communication in their own business-as-usual activities.

3. To know more

There are not direct sources dealing with the establishment of governance structures in research organisations related to science education. It could perhaps useful to consider some general documents dealing with science education policies, such as:

- The European Union report on science education for responsible citizenship
http://ec.europa.eu/research/swafs/pdf/pub_science_education/KI-NA-26-893-EN-N.pdf
- The document on science education policies and practices in Europe developed by Eurydice
http://www.indire.it/lucabas/lkmw_file/eurydice/sciences_EN.pdf
- The policy brief of the SIS Net on science education policies in the European Commission
http://www.sisnetwork.eu/media/sisnet/Policy_Brief_Science_Education.pdf
- The STEM Education policies in Europe Report, developed by Scientix
http://www.scientix.eu/documents/10137/782005/Scientix_Texas-Instruments_STEM-policies-October-2018.pdf/d56db8e4-cef1-4480-a420-1107bae513d5

Other interesting sources could be the programmes on science education developed by universities. In this regard, see for examples:

- <https://education.jlab.org/>
- <https://www.mcgill.ca/ose/about>
- <https://www.howscienceworks.pitt.edu/>

