Training Showcase:

Xplore Health, 
briding the gap between RRI and education

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### Document description

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1 Introduction

Research and Innovation (R&I) bring solutions to the social challenges of our knowledge society, and they have an impact on the lives of all of us. However, citizens are rarely engaged in democratic processes to participate in defining what innovation they want. On the other hand, once the resulting services or products are in the market, citizens are expected to choose whether they want to make use of them or not. However, they often lack the necessary knowledge and skills to make informed decisions. Finally, there is still a wide range of social challenges to be identified and solved while at the same time innovation is also bringing new products and services that may not respond to existing social challenges, and that require strong marketing campaigns to provoke the need.

All this brings us to a growing need to reconsider the governance of science, its role in society and the criteria of what makes R&I excellent research. The aim of this necessary structural change within R&I focuses on enhancing the quality of the research to make sure its outcomes are more aligned with the needs and expectations of society.

To attain this aim, R&I needs to become more open and inclusive and to be performed with the collaboration of different stakeholders (industry, CSOs, researchers, policy makers, learners, educators and their communities). This new paradigm of R&I is called Responsible Research and Innovation (RRI). The EC has identified 6 main policy areas or keys that should be involved in the agenda to attain such a structural change of the R&I system: gender equality, open access, ethics, public engagement, governance, and science education.

To make sure the policy agendas can be properly implemented, Europe needs empowered citizens with the necessary knowledge and with enough capability in scientific reasoning, critical thinking and engaging skills who are disposed to participate in R&I processes and in R&I decision making.

Science education has a very critical role for the implementation of the new paradigm of RRI where a different relationship between science and society is to be established.

“Investing in making scientific and research careers more attractive for young people improves their culture, prepares them to act as well-informed citizens and equips them with the necessary knowledge and skills to match the current and future labor market needs”

2 European Commission. Science With and for Society. Science Education
But how should scientific and research careers be made attractive for young people? How do we need to prepare our future generations to be disposed and prepared to participate in R&I and in R&I decision making?

Xplore Health\(^3\) is a European educational programme that is a proof of concept on how to bridge the gap between research and secondary STEAM education\(^4\) with an innovative educational approach.

It was originally funded in 2010 by the EC, with a FP7 grant, and currently, it is run in collaboration with Foundation “la Caixa” and with the support of the Amgen Foundation. It has proven to be highly successful in all evaluations carried out on a yearly basis and the traffic to its website is increasing significantly year after year. Its portal has doubled the traffic during the last year and has now more than 8,000 visitors a month.

Since its origins in 2010, Xplore Health has been challenged to enrich the programme, moving from a paradigm that focused on understanding and public engagement of pupils into the research process, towards a new paradigm inspired by RRI, where the focus is on publicly engaged science and on empowering secondary school students to be able to participate in R&I processes and in R&I decision making with a focus on achieving the RRI outcomes, such as having R&I more ethically acceptable, socially desirable and sustainable. Such an innovative educational approach aims to train students to become active citizens of the knowledge society that make informed decisions and who can contribute to shape the societal challenges.

In this case study we will explain the evolution of Xplore Health to adapt to the requirements of an RRI knowledge society, and we will invite the reader to reflect on other methodologies that could be implemented to improve STEM education to better contribute to the implementation of RRI.

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3 www.xplorehealth.eu
4 Within STEAM education, students are educated in an interdisciplinary and applied approach within four disciplines; Science, Technology, Engineering and Mathematics, and also transversally with All other disciplines.
2 Xplore Health: Bridging the gap between RRI and education

2.1 Before Xplore Health: working to let citizens enter into the R&I system

The idea of creating Xplore Health started in an outreach department located in the Barcelona Science Park, where a small team was running a strong programme aimed at bridging the gap between education and research, inspiring future scientists and promoting scientific literacy. Overall, the aim was to invite students to enter into the research and innovation system.

The department offered innovative activities where more than 4,500 students per year could interact directly with scientists within different formats of events such as workshops of experiments, fairs were scientists invited visitors to perform experiments linked to their research, theatre plays, stages within labs, visits organised as a treasure hunt and courses for teachers.

All these activities were organised in collaboration between scientists and science communicators, and, although most of them were offered during the week, some of them were also offered during weekends in the centre of Barcelona, in a Gaudi Building called La Pedrera, where they targeted the public at large.

The results of the evaluations showed high interest among students, their teachers, and citizens that attended, and the activities were fully booked only within a few hours after being published. This showed that there was a high demand and interest to bridge the gap between research and society with activities that focused on current research rather than on accommodated knowledge.

Moreover, some of the teachers highlighted the need not to offer these sort of opportunities to their pupils only once a year. This feedback from the teachers and students inspired that team of science communicators to think about an online platform that could bring the laboratory life into the classrooms. The idea was to facilitate teaching resources aimed at secondary school students aged between 15 to 18, with the aim to facilitate them to learn health related topics within the context of current research.

To bring this idea to reality, the first step was to do a benchmarking of projects working in this direction. At that time, i.e. 2009, there were not many of such initiatives in Europe. The team identified some initiatives in the EEUU and one in Europe: a science centre located within a biomedical research campus in Eastern London called Centre of the Cell (COC). COC was developing very appealing multimedia tools with the same focus.

The Barcelona Science Park decided to present a proposal to a call of the 7th Framework Programme of the European Commission. They set up a consortium with some other
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partners including the European SchoolNet, the European Network of Science Centers and Museums ECSITE, COC and the consultancy Ubach Munne. The proposal was accepted and the project was funded by the EC from 2010 till 2012.

After the EC funding ended, the person leading the project moved to the Unit of Public Engagement on Health Research at IrsiCaixa, an internationally renowned biomedical institute of research. Since then, Xplore Health is being run in collaboration by IrsiCaixa and “la Caixa” Foundation and with the support of the Amgen Foundation.

2.2 What is Xplore Health

Xplore Health offers participative multimedia and hands-on resources to facilitate information about R&I (such as virtual experiments, videos and online games), together with educational tools to promote reflexivity around ethical, legal and social aspects (ELSA) related to R&I (such as videos or card games) and resources for teachers to implement such resources with innovative pedagogical approaches.

The educational resources are concentrated within 8 thematic modules covering topics such as how are drugs developed, biotechnology, malaria, HIV/Aids, obesity, mental health or skin cancer, among others. Those topics were selected together with the Project Officer at the EC, based on their interest for the target audience and on the existence of relevant EC funded projects at that time. Each module offers the variety of resources described above to facilitate teachers to work on content and skills for RRI while using innovative participatory pedagogies.

The resources on R&I are:

- **Virtual experiments:** these interactive multimedia resources allow students to perform experiments on line, following the steps of state of the art research and using “virtual” and real lab equipment. One example of one of the virtual experiments was developed within the module on HIV/Aids, where students have the opportunity to learn about one of the strategies that is being followed to develope the HIV vaccine. While performing this experiment, they can also get a more clear idea of how current research is performed, which instruments are used and why it is so difficult to attain such a challenge (see virtual experiment: Participate in the research to develop a vaccine against HIV)

- **Games:** the online games allow students to learn about the latest on health research at the same time while enjoying and playing. One example of this sort of multimedia resource can be found in the module on Malaria, where students are invited to take decisions in a village affected by this illness. They can see how these decisions have an impact on the number of people affected. The decisions involve issues such as investment on education, research and care, among others. In this manner they can learn about the complexity of public health governance (see game Stop Malaria)

- **Videos on current research:** on these videos students have the change to meet different investigators with different specialities who are performing...
health research in different labs around Europe and to learn about their projects. In these videos the researchers explain their projects in a comprehensive way and they use metaphors or educational resources to facilitate the comprehension of specific concepts. For example, in the video “Reading the book of our DNA” which can be found in the module on genomics, the researchers explain how they do research to improve the techniques to “read the book of life that is written in our DNA” and they explain how these techniques work using colourful graphics that represent DNA sequences.

The resources to reflect around ethical, legal and social aspects are:

- **Card games with different formats**: these games are very easy to use. They can be downloaded, printed, cut and brought to the classroom to let students reflect around ethical, legal and social aspects (ELSA). For example, in this game on Personalised Medicine, students can reflect on bioethical issues such as the right to do not know about genetic predisposition to certain illness or about health inequality issues regarding access to personalised medicine, among other.

- **Videos with different opinions**: These videos display different experts who give their opinion about some controversial issues around their research. They are ideal to complement the card games and show to the classroom what some experts think about the issues they have discussed with the card games. See here one example of one of these videos where experts have their say on issues such as overmedicalisation: [Drug development and ethics](#).

### Resources for educators:

- **Worksheets for students**: These guides give teachers hints on how to implement the Xplore Health resources in the classroom while promoting Inquiry Based Science Education (IBSE) and Responsible Research. Example: [Interview a researcher working on cancer](#) is an example of one of these guides where the teacher can find hints on how to introduce the different resources on the topic within a context where students are asked to make an interview.

Xplore Health also offers an **outreach programme** with opportunities for students to participate in face-to-face events with scientists. These activities are workshops where students participate in experiments linked to current health research, making use of real reagents and instruments from labs. The protocols used in these activities are also available on the Xplore Health platform:

- **Protocols of experiments**: helping science museums and research centres to offer workshops with experiments inspired of current research lines. Example: in the protocol developed to [Investigate the AIDS vaccine](#) students can implement one technique called electrophoresis to investigate if a candidate of vaccine
against HIV could be used to fight against different variants of HIV that can be found in different areas of the planet.

The activities are currently being run through “Clusters” located both in museums and research centres in Spain. Apart from offering workshops on experiments, the Clusters offer courses for teachers, where they are invited to join a Network of Pilot Schools with access to seminars on innovative and interactive teaching pedagogies such as inquiry based science education and problem based learning, cooperative learning and group dynamics and formative evaluation. They exchange know-how and promote collective projects through an online Platform. They also have the opportunity to learn about RRI and to reflect on how it can inspire and improve their teaching.

At present, the outreach programme is coordinated from three different Clusters in Spain: Domus, in Galicia; Parque de las Ciencias, in Granada; and IrsiCaixa, Barcelona Science Park and CosmoCaixa, in Barcelona; offering workshops at the CosmoCaixa museum in Barcelona and in some cities in Spain with a mobile open laboratory. An extra Cluster will open shortly in Madrid. All together, these clusters offer currently workshops for more than 25,000 students a year, and courses for more than 120 teachers.

2.3 Objectives

The objectives of the Xplore Health programme are:

- to bridge the gap between research and education
- to promote health by facilitating decision making based on evidence obtained from quality research
- to promote innovative pedagogical approaches by facilitating learning in the context of real life challenges and current research, with reflections around ethical, legal and social aspects, and through inquiry based science education, cooperative learning and formative evaluation.
- to inspire future researchers
2.4 Moving from deficit to democracy

These educational initiatives were aimed at letting citizens enter into the health research system, but in fact the overall aim was promoting the understanding of the current health research. However, since the creation of Xplore Health, the practice of Public Engagement (PE) with science had been evolving. It started with a willingness to promote “public understanding of science” through one-way communication of scientific findings (linked to a so-called “deficit model” which is based on the assumption that an ignorant public has to be educated about science). Next, it evolved towards a more elaborated and more democratic “public engagement in science”. Recognising that science and technologies are social constructs made by human beings, depend upon socio-economics contexts of production and that citizens (notably as tax payers of public research and as knowledgeable partners) should have a say on scientific and technical developments, especially when these become a matter of concern.

Within this change of paradigm, Xplore Health was already seen as an innovative approach within the education community, as it already exposed current research within its ethical, legal and social aspects. However, this new tendency also brought changes in the lesson plans being developed, the activities were modified to invite students to interact with different stakeholders in order to become active citizens of the knowledge society. They were invited to have a say, to communicate the results of their reflections to relevant actors within the system.

For instance, in one lesson plan students are invited to analyse if research centres and the media publish sensationalistic news articles. They are invited to contact the journalists in charge of writing them, and to advice them to better explain, for instance, how far from arriving to the market is a drug being investigated in a certain research centre. Or when students participate in a debate on how to distribute the budget to fight against Malaria, they are invited to send their conclusions through social media and to inform policy makers who deal with such issues. In other lesson plans, they are invited to interview scientists working in industry or to run communication campaigns to improve the social perception of certain research lines.

With all these sort of activities, which are always related to current research, and which are always implemented after students work with the different typologies of resources available in the portal, including scientific, and ethical, legal and social contents, Xplore Health now also aims:

- to help students feel that they are already part of the Research and Innovation system, and that they can contribute to improve it, as active and responsible citizens.
2.5 Moving towards empowering citizens to participate in R&I and in R&I decision making

The new paradigm of Responsible Research and Innovation (RRI) has brought formal, non-formal and informal education to collaborate together with other stakeholders: researchers, industry, policy makers and civil society to empower today’s and tomorrow’s citizens to be able to meaningfully participate in R&I processes, in R&I decision making with a focus on the RRI outcomes, and to raise interest in STEM education and careers. Under the umbrella of RRI, science education is also seen as a key aspect to be considered in coordination with other policy agendas: ethics, open access, gender equality, public engagement and governance. This holistic approach brings in a new paradigm for a transdisciplinary education that better bridges the gap between research and education and focuses on real life challenges with wide societal goals.

Within this new context, Public Engagement is also introducing a more ambitious term that embraces the idea of “publicly engaged science” (Stilgoe, 2014) where public engagement is integrated in an open and inclusive process of R&I and where participants can give relevant input.

This new paradigm is questioning current institutional settings and demanding institutional reflexivity. Within this RRI framework, all societal actors (researchers, citizens, policy makers, business, educators, etc.) are engaged at all phases of the research and innovation process (R&I) and R&I decision making. With such an engagement, the outcomes of R&I will better aligned with the values, needs and expectations of society and will better respond with more sustainable, desirable and acceptable solutions to the societal challenges we are facing today.

But do European citizens have the necessary skills to do so? Do they know enough about how R&I is developed? Are they capable to question a research project and to reflect on aspects such as the definition of the problem, the uncertainties or on whether the scientists involved followed a code of conduct on ethical standards? Are they prepared to ask about gender plans being in place to make sure gender equality is present at decision making levels, in the research group and in the samples being used? Are they sensitive to the need of research being published on open access journals?

If RRI is to be implemented in Europe, we need to make sure that the answer to these questions is yes. And the question here is, how does STEM education need to evolve to facilitate such skills.

In front of this new challenge, Xplore Health added even one extra objective:

- to empower citizens with the necessary knowledge and skills (i.e. scientific inquiry, critical thinking and engagement) to be able to participate in R&I processes and in R&I decision making
But how should a STEM educational project respond to do so? To empower citizens to participate, the EC-funded project PARRISE\(^6\) (Promoting Attainment of Responsible Research and Innovation in Science Education) proposes an educational approach called ‘Socio-scientific Inquiry-based Learning’ (SSIBL). The SSIBL brings together four closely connected concepts: Responsible Research and Innovation (RRI), Inquiry-based Science Education (IBSE), Socio-scientific Issues (SSI)\(^7\) and Citizenship Education (CE)\(^8\) in the formal and informal education of young people. Following their definition of SSIBL deploys the following **pedagogical and learning characteristics:**

1. An understanding of how scientific principles can be transformed and operationalized in **social and ethical contexts**;
2. An understanding of the **uncertainty** of the scientific endeavour and its applications in various contexts;
3. An awareness that experts **disagree** both on scientific and ethical grounds;
4. An ability to distinguish between **scientific**, **social** and **ethical** propositions;
5. An ability to draw on the skills and procedures of **dialogue**, reasoned discussion and argumentation in articulating and persuading for and against certain points of view to confer RRI;
6. A recognition of the **social** and **political context** in which decisions arising from SSI are made;
7. An awareness of the **complexity** of SSIs and that few solutions are straightforward; and
8. A recognition that there are **diverse ways of negotiating SSIs** which depend on the evidence available, the personal, political and social consequences of any decision, and the extent to which the issue divides diverse sectors in society.

An example of how SSIBL can be conceptualised and operationalized is the development of the London 2012 Olympic Park, which offered young people in London the opportunity to explore some controversial scientific and social problems involved in the construction of the Olympic stadium\(^12\).

Within this new paradigm, Xplore Health has started developing new educational resources and activities. Among others, the project is now promoting participatory research and starting to develop educational resources on scientific inquiry.

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\(^6\) PARRISE: “Promoting attainment of Responsible Research and Innovation in Science Education”

\(^7\) Socio-Scientific Issues (SSI) are problems which often arise in our society and have a scientific and/or a technological component and which are trans-disciplinary and have multiple possible solutions with no consensus on how they can be solved.

\(^8\) Citizenship education (CE) refers to the moral and social function of education, and therefore implies reflective, dialogical and democratic learning.
2.6 Participatory research: Healthy Minds

Under this new paradigm, Xplore Health saw the need to combine the online activities with an innovative participatory research project. It was leaded from IrsiCaixa, in collaboration with “la Caixa” Foundation and the EC funded project EnRRICH (www.enrrich.eu), and it was called “Ment Sana” (Healthy Mind). “Ment Sana” is a Community-Based Participatory Research (CBPR) project run in collaboration between educators, learners, researchers and policy makers and following RRI quality criteria with the aim to design and implement health interventions, for students and with students.

The project started in 2015 with a needs assessment, where students chose the topic of stress and depression among a list of health issues and built a collective agenda of interests. In a second phase, to respond to some of the identified interests, different RRI projects were designed and implemented in collaboration between researchers, higher education students and secondary school students. They were also engaged in a participatory governance methodology to culminate the project with a final collectively designed product: a Decalogue of Recommendations for policy makers. The results were presented in May 2016 in CaixaForum Barcelona in a final congress with more than 350 students and high level policy makers from the Catalan Government and the NGO Federació de Salut Mental de Catalunya.

This participatory process gives students the opportunity to learn science through science, and to learn how to design and execute research projects, in collaboration with research groups. The process has strengthened both the research process and its outcomes, and has therefore contributed to excellent research, to finding solutions adapted to the needs and expectations of the end users. It has also contributed to the empowerment of learners and other participants, who have developed scientific inquiry, critical thinking and engagement skills.

Therefore, with these kinds of projects Xplore Health adds two final aims:

- To collaborate with researchers to design and perform research projects to contribute to better align the research with their needs and expectations.
- To empower students to contribute to bring solutions to societal challenges.
2.7 Summary of the aims and STEM education approach of Xplore Health

Aims:

1. to bridge the gap between research and education
2. to promote health by facilitating decision making based on evidence obtained from quality research
3. to help students feel that they are already part of the Research and Innovation system, and that they can contribute to improve it, as active and responsible citizens.
4. to empower citizens with the necessary knowledge and skills (i.e. scientific inquiry, critical thinking and engagement) to be able to participate in R&I processes and in R&I decision making to contribute to bring solutions to societal challenges
5. to inspire future researchers

To attain such aims, Xplore Health promotes an innovative STEM education programme through:

- Collaboration among different social actors
- Learning through real life challenges linked to current research
- IBSE, cooperative learning & formative evaluation
- Reflection around ELSA (ethical, legal and social aspects)
- Reflection on scientific inquiry and research integrity (critical thinking around how R&I is defined and executed: limitations, uncertainties, fraud, problems definition...)
- Participation in participatory research projects and in decision making around R&I
3 Xplore Health from a RRI perspective

3.1 Using of this showcase

Although this showcase has been envisaged as being used in a workshop scenario, it may also be possible to use it as part of a more academically formal programme, delivered either face-to-face or online. The exact usage of this showcase will clearly affect how any RRI training is delivered. In Section 4, a workshop scenario is outlined.

3.2 Learning Outcomes from this showcase

The RRI Tools project has developed an ambitious set of learning outcomes\(^\text{10}\) that it would like to see addressed by those training stakeholders in the principles and practice of RRI. These are set out in the RRI Tools *Learning Outcomes* document, and made explicit in Section 2 of that document. They are divided into outcomes for all stakeholders and stakeholder specific outcomes. Trainers should be familiar with this document, and be prepared to amend and augment it as they deliver their training and deal with particular situations.

Under the ‘All Stakeholders set of learning outcomes’, this showcase clearly addresses Outcome 1 “Be able to explain the concept of RRI ...”. It also explicitly addresses Outcomes 2 “Be able to identify the opportunities ...” and 3 “Be able to identify the possible obstacles ...”. Depending on how training using this showcase is delivered, it is quite probable that many of the other Outcomes will be addressed, although some of the specific agendas that RRI encompasses are not explicitly addressed, especially Gender and Open Access.

In terms of stakeholder specific outcomes, all of them are covered in this showcase. Additional exercises are included to strengthen this, and to develop further RRI understanding amongst the other stakeholder groups.

3.3 Complementing this showcase with other initiatives

One of the reasons for developing the story of Xplore Health into an RRI Tools Showcase was that it was felt to have some generally useful lessons for the community across the European Union. However, we are aware that in the latests EC calls a broad range of projects covering RRI are being sponsored, and exploring other approaches on how to promote RRI in education would be interesting. The excercises indicated below invite trainers to do so.

3.4 Further use of this showcase
After any workshop use of this showcase and at an appropriate point in any online training course, Section 2 should be made available to the workshop participants and online trainees, along with the additional materials outlined in Section 5.

3.5 Limitations of this showcase
The Xplore Health Showcase is intended only to illuminate some aspects of how to implement responsible research and innovation in science education, and is not a complete solution to how to do this. It needs to be used in conjunction with the RRI Tools Policy Brief, with (parts of) the Quality Criteria and the Self Reflection Tool, the Report on the analysis of opportunities, obstacles and needs, and relevant items in the comprehensive toolkit produced by the project, including some “How Tos” sections developed by the RRI Tools partners devoted to education, i.e. ECSITE and EUN. All these resources can be found in RRI Tools.
4 Workshop training exercises

Based on the Xplore Health project outlined in Section 2 (above), this section now sets out how this Case Study might be used in a training workshop involving all of the stakeholder groups RRI Tools addresses. This involves different sessions for multi-stakeholder group discussions (with three or more groups, depending on participant numbers), and final plenary sessions. The workshop leads to a final collectively developed product: a list of pedagogical and learning characteristics of STEM education projects to empower students to participate in R&I and in R&I decision making following RRI quality criteria. It will be co-developed among the different stakeholders involved in the workshop.

The activities come with suggested timings: depending on the number and knowledge levels of participants, this showcase could be used for a half-day or whole-day event. Ideally there would be 20-30 participants and one or two trainers. A model powerpoint presentation has been prepared to be used with this case study.

Depending on how conversant the workshop participants are already with RRI, and how conversant the trainer(s) want them to be, prior to the workshop participants can be asked to visit the Xplore Health website – www.xplorehealth.eu - and to read the RRI Tools Policy Brief. Neither of these should be accessed during the workshop itself, however.
4.1 RRI and education. Obstacles and opportunities

Within the text in this Case Study on Xplore Health, you have followed the evolution of one project in STEM education that started with a willingness to help students understand current research, and which has evolved towards a project that also offers students the possibility to engage in research processes that respond to student’s real life and which are co-developed between researchers, higher education students and secondary school students and teachers. With this evolution Xplore Health aims to move towards an innovative educational model that empowers students to be able to participate in R&I and in R&I decision making.

In the RRI Tools Policy brief, you have also been able to identify the process requirements needed to implement RRI projects: inclusion and diversity, anticipation and reflection, openness and transparency and responsiveness and adaptive change. This document also highlights the outcomes that RRI processes should attain, i.e. learning outcomes (engaged actors and responsible institutions and actors), R&I outcomes (research more ethically acceptable, sustainable and socially desirable) and solutions to societal challenges.

Q.4.1 To what extent do you think RRI and its process requirements and outcomes should inspire STEM education?

a) Think about opportunities and obstacles (30min). In groups, reflect about the obstacles and opportunities of implementing RRI in STEM education. Identify within each group representatives of the different stakeholders (industry, policy makers, educators, citizen, and researcher). What would be the opportunities to implement RRI for each of them? Write the opportunities on green cards and the obstacles in red ones. Identify at the corner of the card the stakeholder or stakeholders who share that obstacle or opportunity.

b) Share the results with the group (30min). In a plenary, share the opportunities and obstacles and stick all the cards on a flipchart constructing one unique mind map. Come up with final conclusions on the participants’ willingness to implement RRI in STEM education.
4.2 About the pedagogical and learning characteristics of STEM education

In section 2.5 we have introduced an educational approach called “Socio-scientific Inquiry-based Learning” (SSIBL) with a list of pedagogical and learning characteristics that STEM education should fulfill, which have been identified by the project PARRISE.

Q.4.2 What are the pedagogical and learning characteristics that should be prioritized in a STEM education inspired by RRI?

a) Reflect within groups on the SSIBL characteristics (30 min). Would you modify the list? Are there pedagogical approaches and skills that you feel should be added or deleted? (you may be inspired by all the aims of Xplore Health that appear in the section 2.7, and by the process requirements and outcomes of RRI described in the RRI Tools Policy Brief). Work on a new list of pedagogical characteristics within groups using a flipchart.

b) Share the results with the group (30 min). In a plenary, every group presents their list of characteristics. Meanwhile, all the cards are clustered in a unique final list of characteristics. This list will be further enriched during the course of the following activities. At the end of the workshop, we will come up with a final list that we may want to publish on the Community of Practice of RRI Tools.11

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11 After this exercise trainers can either follow the next exercises or alternatively they could also change the power point presentation not to show from the beginning how RRI has helped Xplore Health to evolve. In this manner you could make them think about how they would do it. This option could be useful for attendees that did not read the case study before. If you are interested to do so, you can present the ppt until slide 11, and you can stop there and ask participants to reflect on how it could be improved to make it more RRI.

• After they discuss in groups, they can present the conclusions to the plenary.

• Finally you can introduce the next slides with the collaborative processes, and you can also mention that Xplore Health is now developing resources to better promote the reflection on the necessary skills for RRI.
4.3 About the contexts and the collaboration between different stakeholders

In section 2.5 we mention one example of context where students could explore scientific and social problems involved in the construction of the Olympic stadium in London. In Xplore Health each of the modules offer us a context where students can work on scientific and ethical, legal and social aspects.

However, RRI invites us to collaborate with different stakeholders. Xplore Health, in its worksheets for students with lesson plans, also invites them to collaborate with stakeholders during the learning process.

Q4.3 Which and how do stakeholders collaborate in STEM education within socio-scientific contexts?

a) Mapping of stakeholders involved and aims of collaborations (20 min): In groups, choose one of the worksheets for students and explore how it invites them to collaborate with different stakeholders. Analyse the different stakeholders involved (researchers, industry, Civil Society organisations, policy makers and education community) and the aim of the interactions, i.e. do they interact to do a consultation, to inform them or to co-develop something? Think about other educational projects where the learning process involves collaboration with different stakeholders. Analyse again in those ones the stakeholders involved and the aims of the interactions. Write them on a paper.

b) Share the results with the group (20 min): In a plenary discussion reflect around the following questions: Were all the different stakeholders involved? What were the aims of the interactions? Were students exposed to the different pedagogic characteristics identified above? How could it have been improved? If necessary, the list of characteristics may be enriched with this reflection.
4.4 About the engagement during the different phases of the R&I process

If we consider that the process of R&I has the following phases: programme definition or research agenda setting, project design, project execution and implementation phase (service or product development and/or policy decision making).

Q4.4 Should students be engaged in STEM education projects within the different phases of the R&I process?

a) Reflect about STEM education within the different phases of the R&I process (20 min): Can you identify educational projects where students learn about each of those phases? Do you think students should be empowered to participate in each of these phases of the process? Should students of all educational levels be involved in these phases? Work in groups to answer these questions and write the conclusions on a flipchart.

(You may come up with examples such as: students participate in the definition of the research questions, for instance in an experiment with worms, where they are given the worms and are invited to come up with questions. You may also come up with examples of projects, such as nanopinion, where students were invited to give their opinion on what is responsible innovation with nanotechnologies, or student parliaments, where students are invited to participatory governance processes, or Healthy Minds, where they can define and execute a research project that responds to their needs, or quantum spin-off, which promotes interaction between researchers and students and invite the latter to come up with ideas of entrepreneurship.)

b) Share the results with the group (20 min): In a plenary, each group presents the resulting flipcharts with the conclusions on the engagement of students in the different phases of the R&I process. If necessary, the list of characteristics may be enriched with this reflection.
4.5 About reflection around ethical, legal and social aspects

In each thematic module of Xplore Health students are invited to reflect around ethical, legal and social aspects related to the health science topic. To do so, the project offers videos where experts present different opinions, and also card games to facilitate the reflections. These debates help students to learn around some of the SSIBL characteristics mentioned above.

Q4.5 What are the values and needs that lead to different perceptions and socio-scientific controversies? How useful are the card games to facilitate learning on some of the pedagogical and learning characteristics?

a) Values, needs and perceptions around ELSA (20 min): In groups, choose one card game and identify the different values and needs that lead to different perceptions and controversies around the topic you have chosen (e.g. health inequality, animal welfare, fair investment, etc.). Write them on separate post its.

b) Share the results with the group (20 min): In plenary, each group presents their post its and they are grouped in clusters of values and needs. The group reflects on the usefulness of these sort of educational resources to fulfill some of the pedagogical and learning characteristics identified above. If necessary, the list of characteristics may be enriched with this reflection.
4.6 About reflection on scientific inquiry

In Xplore Health you have seen that students can learn about different research projects within each module using the different multimedia tools in the classrooms. In the Healthy Minds project they were engaged in the definition and execution of a research project through methodologies inspired by Community Based Participatory Research (CBPR) initiatives, Science Shops and RRI. These sort of projects help to develop scientific reasoning skills, with activities such as:

- Framing different R&I questions
- Selecting R&I methods
- Reflecting around issues of research integrity
- Considering Gender equality in research teams, in research content and in research groups
- Taking into account issues related with openness and transparency of the R&I process
- Analysing uncertainties and limitations of R&I and/or scientific controversies, and potential improvements to the R&I process
- Debating about the role responsibilities of the participants
- Anticipating expected and unexpected impacts (e.g. ethical, legal, economic, environmental and social)\(^\text{12}\)

Q4.6 How can scientific inquiry and critical analysis of R&I be further promoted in STEM education?

a) Educational approaches to work on scientific inquiry in the classroom (20 min): Do you think that other educational approaches less time consuming, such as using virtual experiments, could also be used in the classroom to engage students in these sort of reflections? Can you come up with examples of educational approaches to work on those?

b) Share the results with the group (20 min): In plennary, each group presents their conclusions. The group reflects on the usefulness of these sort of educational activities to fulfill some of the pedagogical and learning characteristics identified above. If necessary, the list of characteristics may be enriched with this reflection.

\(^{12}\) To better understand some of these sorts of activities in the D1.3 on Quality Criteria of RRI you will find more questions related to these issues that may help to clarify what we are referring to.
4.7 How to improve your educational activities

a) How could you improve your educational activities to fulfill the pedagogical and learning characteristics of RRI? (30 min)

Xplore Health has been evolving since it started, to better empower students for RRI: it has incorporated, in the lesson plans, the need for students to collaborate with different stakeholders, it now offers the option to collaborate in Community Based Participatory Research, and now it is developing tools to incorporate reflections around scientific inquiry.

Think about different resources and pedagogical approaches that you use in your educational projects (virtual experiments, workshops of experiments, card games to reflect on ethical, legal and social aspects, videos, worksheets for students with lesson plans, teacher guides with hints on how to bring the lesson plans to the classroom with innovative pedagogical approaches, participatory research projects, etc.).

Do you think there are some of the pedagogical and learning characteristics identified above that your practices do not fulfill? How could them be improved to address the characteristics that you feel are not aimed? Work in groups.

b) Share the results with the group (30 min). In a plenary, each group presents the resulting flipcharts with the conclusions on how to improve their educational projects to the rest of participants.

Share the final collective product! We invite you to further reflect on this topic in the RRI Tools Community of Practice and to share the resulting list of pedagogical and learning characteristics of an RRI STEM education project that have been co-developed by all participants in this workshop.

5 Useful resources

(1) Model Powerpoint presentation – available in the RRI Tools website
(2) RRI Tools reports referred to in Showcase
(3) RRI Tools Toolkit
(4) References and weblinks listed in Showcase
Training Showcase: Xplore Health, bridging the gap between RRI and education