Equipping the Next Generation for Active Engagement in Science

SEVENTH FRAMEWORK PROGRAMME

DELIVERABLE D3.6: RRI OER Annual reports

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EXECUTIVE SUMMARY

WP3 is a core production Work Package of ENGAGE, responsible for the production of Materials which will involve and excite teachers and students about teaching using RRI contexts, content and pedagogies. While the concept for our Materials was based on a previously successful project - Science upd8 - we have made sure to redevelop it according to the changed needs of teachers, and for all the different countries involved in ENGAGE.

We developed from first principles a 'Materials Framework', starting with top level aims, and a set of 'Goals' that the Materials will teach students, which are fully aligned with the overall project goals. Further, we have defined a set of preferred teaching strategies, consistent with our goals, and with best practice and research into RRI teaching. The result of this Framework is a document which guides the design and development decisions which the WP3 team makes on a daily basis, and ensures a high quality output.

ENGAGE publishes very fast- within 3 to 4 weeks - so that RRI contexts may still be topical when the Materials are used in the classroom. For this we have develop a very efficient production schedule, which involves all team members, and various stages of quality control. It has been successful, resulting in the on-time production of 13 Materials so far.

Finished Materials are translated and localised on each partners' website. Localisation has received a lot of attention, since the Materials are produced centrally, but need to be adapted to different country curricula, and different expectations of teachers and students. We have addressed the issues arising from these needs and formalised a process for localisation which has proved effective.

1. INTRODUCTION

In the ENGAGE model, Open Educational Resources (OER) in the form of curriculum materials are the gateway to teachers' involvement, and professional learning. Materials in our 'teacher inquiry cycle' facilitate the first process of 'classroom experimentation'. They will be published as 'Open Educational Resources' (OER) on our Knowledge Hub (website), to encourage their free use, modification, and re-publishing by teachers, under a Creative Commons license.

To address RRI, The Materials will provide a broad, balanced of key areas of emerging technology in all scientific disciplines which are likely to affect students in their lifetimes, from nanotechnology and novel materials, to genomic medicine and genetic modification, to human enhancement, to geo-engineering.

ENGAGE will produce 60 OER over the project's lifetime. They are of three different kinds: I.Topicals, II.Sequences and III.Projects. to support teachers at the three different stages of the project: Adopt, Adapt and Transform.

2. Materials framework

2.1. Background

After the pilot phase, we decided to formalise the conceptual underpinning of our Materials into a ‘Materials Framework’. The framework was developed during Summer 2014, largely by SHU and OU, with feedback from partners. The purposes of our Materials framework are:

- To guide all our Materials Design and production
- To define our 'RRI Curriculum' ie what we're teaching
  - knowledge about the nature of science
  - scientific practices ie inquiry skills
- To define our RRI Pedagogy ie the kind of teaching we're recommending
  - teaching strategies
  - style of student activities

- Achieve alignment between the project objectives and the Materials
- Agree common approach, and areas of localised difference
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We started by defining top level aims, using the Understanding by Design methodology from Wiggins and McTighe (2005), and these were defined by a set of student ‘Accomplishments’, and a series of ‘Transfer tasks’ that students would be able to do with these skills and knowledge. We then used these to define Goals, using the most coherent set of educational objectives: the US 'Next Generation' science standards (2013). This consists of Big Ideas, Scientific Practices, and Performances which blend knowledge and skills into worthwhile assessments. Together these Goals form the basis of what the activities in our Materials teach towards. The components of our Framework are described in detail below:

2.2. ENGAGE Learning Aims & RRI Competences

Our Aims are accomplishments we want students to have			
A1		Be able to question and evaluate the evidence for a scientific claim, and analyse an issue and possible actions, by applying knowledge and developing a reasoned opinions or decision	
A2		Be able to construct an argument to express an opinion using knowledge of scientific big Ideas, or critique another's argument	
... or more clearly, 4 transfer tasks we want students to be able to do			
A1	T1	Consider claims critically	Critically evaluate the strength of the evidence for a claim about emerging science/technology, from a media report

A2	T2	Weigh up issues	Come to an informed opinion on a life, community or society decision, taking into account scientific and other perspectives
A2	T3	Argue an opinion	Argue for your opinion on a socio-scientific issue
A2	T4	Compare solutions	Evaluate possible solutions to science/technology problems, developing criteria, applying knowledge, and using data

2.3. ENGAGE RRI goals

Big idea/ Scientific Practice	Goal short name	Goal	Coverage	Type
		The aims lead to 10 learning Goals - 4 areas of Nature of Science knowledge		
Science in Society	Impact of technology	Science and technology are intimately linked, driving each other forward. All new science-based technology carries risks as well as benefits. You can assess risk by measuring its probability. People tend to over-estimate unfamiliar, invisible or long-term risks, and accept risks associated with choice, or short-lived effects. To weigh up a risk means combining its probability and the scale of the consequences, and balancing against the benefits to the individuals or groups affected. Technology can also have unexpected consequences, and so people are cautious about making decisions until sufficient research is carried out to consider as many impacts as possible, and Governments regulate the process.		
	Big science	Science is no longer an individual search for knowledge, but a collaborative enterprise, done in teams. Because it is expensive and complex, it is funded largely by corporations, governments and funding. The 'science that gets done' is therefore politically determined and tends to favour practical applications, in areas like health and medicine, technology, and solving social and environmental problems.		

	Value perspectives	In emerging science and technology, there are often few 'facts' which are certain. Claims should make clear the degree of uncertainty. Science can weigh up the evidence, and which explanations have the most support, but it cannot provide certain answers. Sometimes implications can are seen as doing something 'wrong'. There are different ways of dealing with ethical dilemmas including utilitarianism (the decision which leads to the best outcome for the greatest number), duty-based thinking (using accepted ethical principles). Decisions should be made by taking into account the views and concerns of all participants. There are different ways of reaching decisions e.g. majority voting, consensus building by resolving conflicts.		
	Media reporting	Much of our scientific information is interpreted by the media, who may give an unbalanced, biased, black and white or sensationalised account, the source of information needs to be assessed in terms of its purpose, and scientific credentials, and recency.		
		... and 6 inquiry skills		
Ask & define	Define problems	Define the issue being inquired into, the scope, what is required for a solution, and to identify the most important factors and the known/unknown information.		Scientific Practice
Analyse & interpret	Evaluate solutions	Evaluate the merit of a solution or competing solutions to a real-world problem, based on scientific ideas and principles, empirical evidence, weighing up benefits and risks and/or logical arguments regarding relevant economic, societal, environmental, ethical considerations.		
Argue & Decide	Use arguments	Write or present orally an argument supported by empirical evidence and scientific reasoning, and identifying values based thinking, to support or refute a viewpoint on an issue or a solution to a problem. OR Critique an argument, identifying possible weaknesses, relating to students level of knowledge and using reasoning and evidence, or critique two arguments on the same topic, or identify flaws in their		Scientific Practice

		own arguments and improve them in response to criticism.		
	Make decisions	Synthesise scientific knowledge, evidence, implications, and value perspectives into an informed opinion.		Scientific Practice
Evaluate & Communicate	Critique reports	Critically read media reports about science, identify the data and evidence, and values thinking used to back up the claims, and evaluate its strength in terms of repeatability and reproducibility.		Scientific Practice
	Communicate ideas	Be able to effectively communicate opinions and accomplishments with text and illustrations, both orally and in writing, in a range of formats, using the major features of scientific writing and speaking.		Scientific Practice

2.4. RRI Topics & Dilemmas

RRI area	RRI Contexts to choose from	Possible Dilemmas	Ideal RRI Goal to cover with this context
Energy	Fossil fuels, artificial photosynthesis, biofuels, photovoltaics, nuclear fusion, fuel cells, hydrogen economy, new battery technology	Should we build more nuclear power plants? Should solar panels or electric cars be sold cheap so people will switch?	Construct arguments
Biomedical	Stem cells, organ transplants, Body implants, prosthesis, regenerative medicine	Are grow your own organs better than transplants? Should parents be able to keep extremely premature babies alive?	Evaluate solutions
Genetics	Genetic data, personalised medicine, GM food, Genetic engineering,	Should parents genetically engineer their children? Should everyone have access to their genome, whatever bad news it tells you? Should we bring back ancient animals? Is human cloning wrong? Are GM organisms an environmental threat?	
Materials	Nanomaterials, nanomedicine, Aerogel, conductive polymers, graphene, high temperature superconductors, nanotubes, 3D printing	Could nanoparticles poison us? Should consumer products be allowed to contain nanotechnolgy?	

Climate	Coping with climate extremes, reducing CO2, geoengineering	Can we stop global warming? Will it threaten our way of life?	
Health	Diets, Risk factors for disease, Drugs for developing countries, pandemics, new antibiotics, new vaccinations	Should sugar be classified as a drug? Should we allow cosmetic surgery to solve teen body image problems? Should people pay for treatment for health problems due to lifestyle? Should you be allowed to take cognitive enhancing medication? Should animals be used for research? Should you have the right to decide whether to be vaccinated, more than your parents?	
Pollution	Linking pollutants to disease,	Are drug companies evil? Are childhood diseases caused by air pollution? Is it safe to eat fish?	
Electronics	Exoskeleton, Robotics, unmanned vehicles, Artificial brains, augmented reality, Flexible electronics, electronic noses		
Transport	Alternative fuels, driverless car, flying car, jet pack, hovertrain, space plane,	Should we make electric cars to fight global warming? Is space exploration worth the money?	
Environment	Species extinction, biodiversity, deforestation, recycling	Should plastic bags be banned? Should we protect endangered species? Is animal testing necessary? Should we stop cutting down trees?	

2.5. ENGAGE Pedagogies

A checklist of strategies based on what's known about effective pedagogy in this area, and what students struggle with. The description should provde clarification, and exemplification.

Type	Best practice strategies for teaching argumentation
Listening	Give students opportunities to practise listening to each other's arguments
Questioning	Give students opportunities to practise asking each other questions
Persuasion	Give students opportunities to practise persuading others of their claims, with justifications based on knowledge and sense-making.

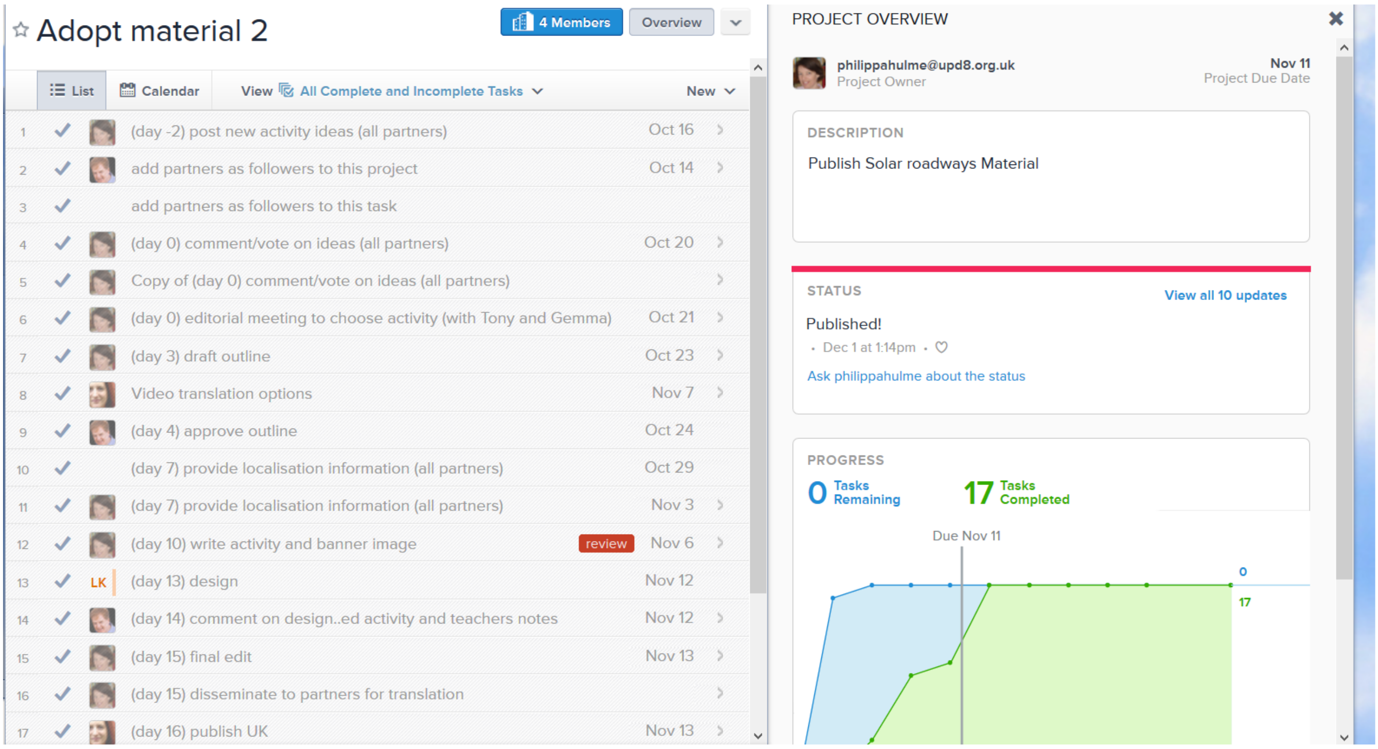
Defence	Give students opportunities and guidance to defend their claims against others' counterarguments
Issue identification	Give students opportunities to practise identifying value-laden issues worth discussing
Vary format	Vary and choose the modes of discussion between teacher-led, whole-class, small group depending on the objectives.
Claim, evidence, reasoning	Teacher models the parts and process of an argument - there will be a 'Lifeline' for this.
Devil's advocate	An effective way to encourage whole-class debate is for the teacher to deliberately take the opposite opinion to the students and argue.
Revisit decisions	It is important to encourage student reflection, so they can reconsider the issue question and whether they have now changed their mind, and why
Ground Rules	Establish and model rules for discussions (everyone has opportunity to express their views, listen to others, appropriate ways to criticise, accept criticism, argue and reach consensus).
Group work	(to add) How to establish effective groups for discussion
Expressing your opinon	It is OK for teachers to be open as to what their opinion is on an issue, if done in a way that doesn't over-influence students. Pretending to be neutral is not authentic.
Arguing with technology	Teacher models the discussion using software tool or application (e.g. Litemap see comments in Ban Cola)
Mapping argumentation in the News	Teacher presents a list of references about the topic and students will map the arguments from the selected narratives

3. Process of materials development

3.1. Materials Production process

To achieve our goal for fast publishing of Materials, WP3 has worked out and piloted a production process which allows us to go from ideas generation to website-ready in a 3-4 weeks. This involves mainly the SHU team, leading WP3 and the 'science upd8 team' of 'Materials experts', as well as contributions from the project partners.

To manage this complex process we use ASANA Project Management software, which allows us SHU to see at any moment, where the production is, whether there are any delays, and provides a structured forum for discussion of a problems and solutions. An exemplar task list from ASANA, with responsibilities and milestones for the production of a Material, is shown below. Two important features of the process are stages of quality control, and stages of partner input, discussed in the section below.



Quality control

The WP3 leader is responsible for quality control, which is reviewed and detailed specific feedback is given with discussion and meetings where necessary, at the Outline stage, and at the draft stage.

Partner input

All partners are invited to contribute to the development at various stages, to ensure that what we produce has buy-in, and is applicable to the different educational contexts in partners' countries.

- Ideas selection stage – partners can a) devise ideas, b) vote on their preferred idea
- Outline stage – partners supply information from their own country to be used in context setting and data analysis
- Localisation and translation stage (see later section)

Teacher input

An ongoing development is to open up the development process so that teachers can contribute to the ideas selection, and to the treatment of the ideas in outline development. We are currently working with WP2 to create a widget on the website homepage, inviting teachers to vote or suggest ideas, through a link with the Pinterest online software.

3.2. Adopt Materials criteria

To stay aligned with the ENGAGE goals and Materials , we apply quality criteria at two stages during Materials development:

Idea selection Here we use the 6 'Productive Dilemma' criteria, co-developed by partners, to ensure that Materials cover all the requirements set out in the DoW. The WP3 team member who devises the ideas, writes about how it meets each criteria. The partners who review the ideas comment on this fit. Not all real-life issues are equally effective for teaching curriculum science. We invent the notion of a 'Productive Dilemma' as a set of criteria with checklists to help teachers

a) evaluate possible socio-scientific issues issues
b) craft an issue so that it meets the productive dilemma criteria

Criteria	The Dilemma ... to make into a 'do, review' checklist
1. It's authentic	... should be a real question, choice, or action that students, either now or in the future, might consider in response to news in the media about emerging science or technology
2. It's controversial	... should not be an obvious choice or action for students, in order to merit thought and discussion.
3. It's engaging	...is likely to be interesting to most students, either because we have tested this, or because it has a 'hook'. Hooks could be a story with strong human interest, or what we know students like about science, e.g. popular topics with boys/girls, concerns about the future, lifestyle, disasters, celebrities.
4. It's covered	... should require the use of science in its resolution, which applies knowledge that is part of the national curriculum (or equivalent), at an appropriate age-level
5. It's social	Some decision-making, even based on scientific knowledge influences the life on the individual. This can be a good starting point, however we are more interested in broadening students; view to the impact on society, environment, economy etc. For example, drinking soft drinks or not is an individual decision, however banning coke is a decision that influence the lives of many people and the considerations may be different.
6. It's RRI	... should apply one of our RRI knowledge areas or RRI skills RRI Knowledge areas: Technology, Big science, Values thinking, Scientific Media RRI Skills: Define problems, Evaluate solutions, Construct arguments, Critique arguments , Interrogate media, Communicate ideas

Outline stage: Once an outline is written, the WP3 WP Leader reviews the outline to see the fits all the elements of the Engage Materials Framework.

The WP3 team also conducts regular overall retrospective reviews of the Materials developed.

3.3. Website publishing

The main way that Materials are disseminated to teachers is through the ENGAGE website. Materials are translated by partners and published on our multi-lingual platform, with duplicate ENGAGE sites in each partner language. We have implemented a system where finished Materials are immediately distributed to partners, who are expected to produce a translation and have the webpages ready with downloadable documents within 3 weeks.

3.4. Review of success

The production schedule is regularly reviewed in terms of efficiency and effectiveness, at WP3 team meetings. We have dealt with a number of issues:

- Speeding up development for particularly topical issues, like Ebola
- Managing partner translation to keep to timelines
- Ensuring high levels of partner input at the voting stage

4. Localisation of Materials

To make ENGAGE materials relevant to each country, there will be a 'localisation' stage in production where specific details and cultural references can be changed. For instance, in the exemplar sketched below on using genetically modified mosquitoes to combat dengue fever, the context can be localised by imagining a future outbreak in each country, and using the details of the organisation that might make the decision (this is easy as the Materials use MS PowerPoint, for easy customizability). Learning objectives can be adapted to the national framework, and particular aspects of pedagogy can be emphasized locally.

4.1. Areas of commonality and localisation in Materials

The materials are centrally designed in an effort to have a common base between the materials that will be used in all the partner countries. Since the main purpose is to design materials that promote RRI, all materials are designed based on the Materials Framework agreed within the consortium on what is defined as RRI, and the different types of skills that are considered important in the teaching of science. More specifically, the following aspects of the Materials are common:

- Emerging science and technology contexts
- RRI goals
- Structure and design of materials

Despite of the decision to have a common structure and design for the Materials, it was considered important to localise the Materials to meet the individual needs of each country and their science curriculum. The main reasons for localisation:

- An initial review of the curriculum of the partner countries demonstrated different content and emphasis on different skills (Deliverable 1.1)
- Research has shown that when the materials are relevant to students' lives, science is more engaging. Therefore the effort during localisation is to use information and data from each partner country to make the materials relevant.
- RRI includes ethical and moral aspects and these aspects are different in each country

Aspects of Materials which are localised:

- Specific contextual information (e.g. information about the sources of energy used in each country)
- Scientific data (e.g. data about consumption of energy in each country)
- Science curriculum links (each partner provides the links to the national curriculum)
- Additional content (e.g. according to the national curriculum, links to further knowledge)
- Web links for news stories and media (e.g. news stories from the local press from each country)

4.2. Procedure for localisation

Even though the materials are centrally produced, the production schedule has several points where partner inputs can localise the content. This process was discussed and agreed with all partners during the last project meeting in Paris. The process is coordinated through the management system ASANA, with the following steps:

- Ideas input: partners are encouraged to suggest ideas about lessons to be developed
- Idea voting: partners vote explaining why they prefer the specific idea, and based on the majority the materials are designed
- Outline stage: during this stage the outline of the materials is designed and the partners are requested to provide any additional information that is incorporated into the draft Material
- Post-final draft: The final draft is provided to all partners and at this stage they can make adjustments to the activity or data, and at the same time translate the Material.

While we try to ensure that each Material is relevant to as many partners as possible, it is likely that for any chosen Dilemmas there may be a few countries for whom it will not be relevant. So ultimately the partner can choose not to publish a particular Material in this case.

4.3. Review of localisation by partners: issues and solutions

In order to identify issues and concerns regarding the localisation of the materials and improve the process, the partners were asked to respond to the following questions:

1. What are the main processes involved in the localization of the materials? Elaborate on the following:
    a. Other than translating the materials for ADOPT 1 what other changes have you made and why? (e.g. are these changes related to the curriculum of your country or to any other local factors? Explain)
    b. What were you main concerns and challenges when translating and localizing the materials for ADOPT 1? (e.g. content not suitable for the curriculum in your country? scenario not relevant for the students in your country?). How did you deal with these concerns and challenges?

c. Other than translating the materials for ADOPT 2 what other changes have you made and why? (E.g. are these changes related to the curriculum of your country or to any other local factors? Explain)
d. What were you main concerns and challenges when translating and localizing the materials for ADOPT 1? (e.g. content not suitable for the curriculum in your country? scenario not relevant for the students in your country?). How did you deal with these concerns and challenges?
e. What are some suggestions to improve the localization process of the ADOPT materials?

2. If you are one of the countries that have piloted materials before and during the summer respond to the following:
   (a) Which materials did you pilot, and what changes did you make? Explain the reasoning behind the changes.
   (b) Compare the process of localization during the piloting with the process of localization during the ADOPT stage. What are the main differences and what would you change during the ADOPT stage when localizing to make the materials more relevant?

The main outcomes of the reporting from the partners are summarized below:

A. Main processes involved in the localisation of materials

According to the review from the partners, the main processed involved in the localisation other than the translations are: making the link between the materials and the national curriculum, identifying and providing weblinks in the national language of the partners, and finally suggesting alternative recourses in the language of the partner to accompany the resources in the English. Some representative answers from the partners are provided below:

"In the localization process we mainly changed the section "curriculum links" in the teacher guide in order it to be in line with the Greek science curriculum. No changes in the power point presentation, as we feel that it is in line with our countries' educational context."

"We have added some weblinks in Spanish which cover the same ideas as those in English, when a word-by-word translation could not be found of the original links"

"Generally, the presentations and guidelines (PPT and Word-docs) have seen very limited localization apart from translation. In contrast, in the webpages **presenting** the subjects we **have** supplemented links to Norwegian articles that match each topic. Our next step will be to modify the teacher guidelines and make them more flexible, e.g. suggesting how the Norwegian resources might be used to supplement/replace the English and suggesting how activities can be organized differently, different time frames"

B. Suggestions to improve localisation

The partners suggested the following actions in order to improve the localisation process:

- *Find a way to share concerns and problems during localization, for example via a google doc or a thread in ASANA, so as to exchange ideas and solution to problems.*
- To use the “notes” section in the Powerpoint presentations only to write notes addressing the teachers.
- To include the timing in the teacher guide for all the materials.
- To have a policy about the banner images. It is currently unclear for us how many images must appear in the banner and how often it must be updated.
- It is very useful that those responsible for releasing the materials write a comment in the Asana task when a material is ready. In this way those who are following can get a notification about starting the translation without having to check the task.
- Longer deadlines for contribution such as voting for ideas or providing localization information would be appreciated.
- It would be very interesting to share ideas with other non-UK partners about how to localize materials successfully within the time constraints of the Project.

Comments from the partners who have piloted some of the materials suggest that further localisation occurs when the materials are actually used by the teachers in the classroom. During that stage the materials are changed by the teachers in order to not only fit with the curriculum, but also to fit with their teaching style and the level of their students.

5. REFERENCES

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United States 'Next Generation' science standards. Achieve. (2013).