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Open Educational Resources for Responsible Research and Innovation: a case study with Brazilian universities and schools

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ABSTRACT

This paper presents a qualitative case study developed in Brazil about "GM decisions" – an open educational resource (OER) of the ENGAGE project. ENGAGE aims to identify key strategies to increase Responsible Research and Innovation (RRI) awareness at scale through OER in countries beyond Europe as well. This study investigates how OER can be easily disseminated to foster RRI inquiry skills. This research focuses on schools and universities located in different states in the south and north regions of Brazil. Participants used the ENGAGE GM decisions game to develop informed based opinion about genetic modified food. Findings of this study shows that 1,473 learners coordinated by 36 research educators participate in the GM food activities within 1 month. They mentioned that this OER can be easily embedded in the Brazilian curriculum but it requires a proper planning. Six skills were identified by educators: devise questions, interrogate sources, examine consequences, justify opinions, use ethics and communicate ideas.

Keywords: RRI, GM food, Games, weSPOT, nQuire-it, LiteMap.

INTRODUCTION

This study, developed by the COLEARN research network, investigates Open Educational Resources (OER) for Responsible Research and Innovation (RRI) that can be easily spreadable and foster the development of ten RRI inquiry skills described by the ENGAGE framework.

The European project ENGAGE aims to spread the teaching and learning of RRI by connecting cutting-edge Science and Technology with educative materials (Sherborne et al, 2014). Its platform (EngagingScience.eu) combines OER for students, open online courses and community of practice for innovative teaching (Okada et al., 2105). ENGAGE aims to identify key strategies on how to increase RRI awareness at scale through OER in countries beyond Europe (Okada, 2016).

This research focuses on schools and universities located in different states in the south and north regions of Brazil that used the “GM decisions” OER of the ENGAGE project about genetic modified (GM) food. The COLEARN community performed several webinars about the ENGAGE project and the concept of RRI (see Figure 1 and Figure 2) in which participants reflected on the dilemma of buying or not buying GM food and deciding if this kind of food is desirable or not in our society through evidence-based opinions.

Participants in the UK and in three states in Brazil (Ceará, Santa Catarina and Paraná) were 43 educators in various classrooms, 3 research-students, 4 research coordinators and 5 facilitators, who used Google Hangout, ENGAGE OER weSPOT and nQuire-it tools. Some of them used laptops and mobile phones to capture their group discussion for co-authoring posters. The video clip of the webinar is available at YouTube with 119 views (on the 30th of November, 2015).

Figure 1 – ENGAGE game about GM decision
Would you buy GM food? Google Hangout

Figure 2 – Google Hangout about the ENGAGE activity in weSPOT tool for participants from the UK and 3 states in Brazil .

The European Commission has highlighted the importance of RRI in Education through its Science in Society *FP7* and *Horizon2020* Programme (EC, 2010; 2012). Thus, our RRI approach focuses on inclusive engagement for responsible citizenship through the discussion of key questions: "*Why do it? For what purpose and goals? Are these desirable? What are the motivations? Who could benefit and how? Who might not benefit?*" (Owen, 2015).

The concept of RRI has been introduced by the European Commission during this decade to highlight the transparent and interactive process by which citizens and innovators help each other. All societal actors should share informed-based opinions and ethical views about an innovative product or a new method. They must discuss potential risks and benefits during the whole process of scientific development (Sutcliffe, 2011; EC, 2012).

Scientist and non-scientists must reflect together on the applications and implications of innovations for society. This process should be inclusive, interactive, anticipatory and transparent, being based on societal needs, expectations and ethical values as to better align innovation outcomes.

Science education has a crucial role in educating the next generation for scientific literacy, responsible research and public engagement in scientific processes and decisions for innovation (Ratcliffe, 2003; Ryan, 2015). Science educators/teachers might meet various challenges to:

1. Support students to discuss and develop evidence-based opinions;
2. Equip students to be responsible citizens with and for society;

3. Develop their own skills for embedding authentic socio-scientific issues and inquiry projects into their curricula.

In order to overcome these challenges, Okada (2015) highlight three requirements: inquiry based science education, topical issues for authentic learning and teachers' continuing professional development.

The first challenge, inquiry based science education is considered the basis for helping learners develop scientific skills, responsible values and lifelong learning. Inquiry based learning is a constructivist approach, which supports students in active experimentation (Dewey, 1933). It is based on a cycle of various steps: questioning, planning method, obtaining and analysing data, drawing conclusions, reviewing outcomes and communicating results. These steps foster scientific reasoning, which is essential for learners to act as responsible citizens representing society's needs in new scientific developments. They also need to be equipped to work as qualified professionals responsible for innovation that is desirable, acceptable and sustainable.

The second challenge requires integrating topical issues and authentic scenarios into the curriculum. This means also connecting informal and formal learning to enrich teachers' lessons. Topical science from science-in-the news and open resources available in science centres or museums will help students link science to contexts (Ratcliffe, 1997). Collaborative learning with peers, educators and experts will foster meaningful science learning, which is connected to students' lives (Solomon, 1987). Science educators play an important role. They need to equip students for making sense of the cutting edge technology and science that affect their lives to make better decisions collaboratively in the present and for the future.

Finally, the third challenge is that teachers will need continuing professional development (CPD). They need to feel capable of using socio scientific dilemmas and topical issues related to emerging innovations to scaffold students inquiry based learning. They need to develop pedagogical know-how and experience to help students integrate conceptual and practical knowledge into ethical values for developing evidence-based thinking (Harris &Muijs, 2001). Science teachers must also be equipped for supporting students to understand how scientific research is developed in a responsible way.

RRI CURRICULUM FRAMEWORK

RRI is an inclusive approach to ensure that societal actors can understand risks and benefits of scientific developments and make responsible decisions (Von Schomberg, 2013). RRI considers that technology and science progress are the basis for a better future. However, innovations must be planned carefully to address societal needs in accordance with societal values in order to maximize the benefits and reduce any harmful impact (Sutcliffe, 2011). The ENGAGE RRI materials aim to "help teachers equip students with RRI inquiry skills to form evidence-based opinions on societal needs and social values". The RRI curriculum developed by ENGAGE presents a framework which integrates 4 areas of science-in-society knowledge: technology impact, Big Science, values thinking and Science-Media.

Scientific inquiry skills for RRI focus on ten abilities with the aim to equip students for active engagement in contemporary science. These skills are: interrogate sources, use ethics, examine consequences, estimate risks, analyse patterns, critique claims, justify opinions, communicate ideas, devise questions and draw conclusions (Okada, 2015).

FINDINGS

Data collected during the period of one month show that the ENGAGE project "GM decisions" was used in various scenarios, disciplines, age-groups and with different learning outcomes. A large amount of data was captured through these initiatives via different technologies, such as Google (hangouts and semi-structured interviews), weSPOT (teaching-learning notes, photos, maps, and discussion), nQuire (images), LiteMap argumentative dialogue mapping, Facebook messages, Youtube videos and institutional websites where new OER related to GM food were published and co-authored collaboratively.

Table 1 provides an overview of the three initiatives which occurred in October - November 2015. These initiatives involved multiple societal actors from various disciplines, in both higher education and secondary school, formal and informal learning settings and face-to-face and online events supported by technologies developed at the OU-UK.

States	**Ceará**	**Santa Catarina**	**Paraná**
GM decision activity	CPD Programme - 1 month 300 attendees face-to-face activities	CPD event - 1 day 150 attendees face-to-face activities	Research network - 1 month 17 courses in H.E. and 1 school face-to-face and online activities
Area	Education and technology in digital centers for people who do not have access to internet in their houses	Education for secondary schools	Higher Education courses: Digital Design, Chemistry, Physics, Maths, Sports, Social Science, Portuguese, English, Spanish, Biology, History, Philosophy, Music and Pedagogy
Organised by	Secretary of the State of Ceará - Brazilian government	Universidade Federal de Santa Catarina (UFSC)	Pontifícia Universidade Católica do Paraná (PUC-PR)
Purpose	Digital inclusion	Learning beyond school	Participatory innovative learning
Coordination team	1 coordinator, 3 facilitators 2 technologists 1 Agrobiodiversity scientist	1 coordinator 2 facilitators 2 technologists	1 coordinator 13 lecturers and PhD students 10 researchers
Technologies	GoogleHangout, Facebook, Youtube, weSPOT (European inquiry platform), Mobile apps, nQuire-it, LiteMap		
Participants	30 pre-service and in-service teachers, local communities	40 in-service educators	16 teachers, 353 students, 500 visitors, 498 users
Active participation	30%	70%	90%
Outcomes co-authored by participants	1 workshop, 2videoclips	2 posters, 1 workshop, 2 videoclips,	1 exhibition, 9 games, 4 new OER, 42 illustrations, 1 webinar, 28 concept-maps, 1 sign-language activity for deaf people
Challenges	Preparation and dissemination		
Benefits	It is easy to embed the lesson in the curriculum, to promote collaboration among teachers researchers and students.		

Table 1: Brazilian initiatives on GM decisions (http://www.engagingscience.eu/en/2015/02/20/gm-decision/).

Evidence reveals that the "GM decisions" integrated to two pedagogical tools (dilemma and group discussion) increased teachers-participants' awareness on RRI. It inspired reflective practitioners to adapt the ENGAGE OER to their different contexts and also recreate new ones (Figure 3).

Figure 3 – OER developed by the PRAPETEC research group with educators, students in various course areas in Higher Education and Secondary Schools.

In addition, some participants proposed several suggestions for extending the activity into RRI projects. Students interacted with researchers and scientists and co-created various examples to communicate their results. Qualitative data illustrates the ten skills that can be fostered not only in the European curriculum, but also in many Brazilian states. The uses of technologies to capture the RRI group discussions helped groups organise the debate, complete the game as learners and co-author posters to justify their opinions based on the arguments risk-analysis provided by the GM decision game (Figure 4). The new OER contextualised by the own societal actors who participated in the initiatives aim to increase RRI awareness in Brazil through an inclusive approach that goes beyond the ENGAGE project target, including deaf people, older citizens, primary school and local communities.

Figure 4 – ENGAGE “GM decision” game deployed with two groups pf teachers in Santa Catarina The results of the games were captured with weSPOT – PIM app

Two key benefits were identified by the facilitators of the events, educational researchers and teachers in the three initiatives:

1. GM decision can be easily embedded in the Brazilian curricula in various states as it engages a participatory community of students, researchers from schools and universities.

   “*The GM decision dilemma promotes open-ended discussion engaging participates to take initiatives to co-investigate the issue beyond the face-to-face lesson*.” (Research-coordinator from Ceara).

   “*Teachers who participated in the CPD event indicated that the activity allows interdisciplinary and collaborative work”* (Educator from Paraná).

   “The teachers from Santa Catarina who participated in the GM decision workshop have shown commitment. They were able to link the lesson with their curricula and have shown interest in using and integrating the technologies presented in workshops to encourage and motivate students in the classroom” (Facilitator from Santa Catarina).

> *"All activities performed in Parana were included in the curricula for undergraduates or secondary schools in the classroom. The work involved: teachers, students, contents and schools"* (Researcher-Lecturer from Paraná).

> "*The GM decision activity facilitated multidisciplinary work among students and teachers from other disciplines. Participants mentioned that the lessons were very interactive and meaningful*" (Teacher from Paraná).

2. "GM decisions" also engage participants to reflect on dilemmas which are relevant to society and develop useful RRI skills through formal and/or informal learning.

   "*In Ceará, when teachers completed the "GM decision" lesson in groups, they mentioned that their engagement helped them reflect on how they could use it in the classroom for their students to feel engaged with the GM dilemma as well. They also found the technologies use during the event helpful to connect formal and informal learning as well and applying it in the community centres*" (Facilitator from Ceará).

   "The majority of educators-researchers who contributed to the workshop mentioned that the debate face-to-face discussion supported by technologies might increase students' participation" (Researcher-coordinator from Santa Catarina).

   "*The involvement of students in activities in Paraná exceeded expectations. The tasks introduced helped students to generate more questions and arguments resulting in very reflective interaction in the classroom"* (Education and Technology researchers from Paraná).

Additionally, participants also highlighted key challenges related to three issues:

- Preparation: The majority of educators' teams responsible for the three initiatives emphasised that collaborative planning is essential for deploying the GM lesson successfully at scale in a short time. All actors who are supporting the initiative should prepare the tasks, time, interaction and support before, during and after the event. This will help the coordination team to assure that the objectives will be addressed during the available period, the problems will be minimised and the impact maximised. This means selecting the resources (print materials), checking technology (URLs), anticipating problems (no internet connection) and identifying extra resources (post-its, poster paper, video clips about the issue and local science-in-the-news).

- Extra technology (hangouts, weSPOT, nQuire and LiteMap) might be useful and relevant for promoting digital literacy integrated to scientific literacy. The coordination team tested the tools in their cities. They also prepared local guidelines to facilitate access and use of the tools, particularly for those who were not familiar to them.
- All collaborators from the three initiatives mentioned that dissemination is the key for large scale participation. In order to facilitate this process, clear and brief news via blogs, newsletters, videoclip invitations and social media will be useful. The other motivation is to disseminate how participants' needs or interests will be approached (e.g. certificate, networking, badges, awards, partnerships, professional development, etc..

Various comments were described by educators related to six RRI inquiry skills presented by the ENGAGE project.

1. Devise Questions: Define a clear scientific question which investigates cause or correlation relationships between different factors.

> *"Educators used the GM activity to help students draw up new questions and investigate answers based on their curiosity. They created these questions: "Do we know what we eat?", What is the origin of our school lunch food? Is there any GM food in our lunch?" (Educational researcher) 30/11/2015.*
>
> *"The exhibition propitiated reflection on the knowledge related to agricultural biodiversity. The exhibition presented the GM dilemma to all visitors: Do you know what is transgenic? Would you buy (T) transgenic? Do you think that it is possible to eliminate all pesticides from food? Do you know what the symbol to represent transgenic foods is?" (Exhibit: Agrobiodiversity) 16/11/2015.*

2. **Interrogate Sources**: being able to question different sources and assess their validity and trustworthiness by judging the reliability of the source, checking for bias and evaluating evidence for claim.

   “Undergraduates selected sources of information recommended by educators and they also brought other references from the web. They discussed the reliability of open sources including articles, reports and videoclips. They also had to explain why they selected the sources to use in their projects” (Lecturer) 30/11/2015.

3. **Examine consequences:** being able to evaluate the merit of a solution or competing solutions to a real-world problem, based on scientific ideas, principles and empirical evidence, by identifying and reflecting on consequences and/or logical arguments regarding relevant economic, societal, and environmental considerations.

   “Visitors of the exhibition were able to reflect on the transgenic dilemma through the questions highlighted in the exhibition. They also shared their opinions about the consequences of non-transgenic food on the Facebook page about the event. They became more aware that there is no symbol representing transgenic foods in the products in Brazil. They think that people consume transgenic food without knowing its origin. Consumers do not know the amount of pesticides in the food and consequences to their health” (Exhibition organiser) 16/11/2015.

4. **Justify opinions:** being able to synthesise scientific knowledge, implications, and value perspectives into an informed opinion by describing key arguments 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.

   “Secondary school students supported by academic researchers, specialists and their teachers explained their opinions based on the information that they collected and evidence that they selected from various sources.” (Secondary school teacher) 30/11/2015.

5. **Use ethics:** Being able to understand and use three kinds of ethical thinking: utilitarianism, rights and duties, virtues in order to make informed decisions and explain why different people may have different viewpoints about an issue.

“Ethics is not discussed in the secondary school. Pre-service educators in their inquiry projects about GM discovered that there is no symbol to represent transgenic in Brazil and the references are not enough for people with special needs. They developed a sign language symbol for GM food” (Lecturer in education) 30/11/2015.

6. **Communicate ideas:** Being able to effectively describe 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.

“The participants of the PRAPETEC group from PUC-PR produced videos answering questions and created and shared various photos of the exhibition. The exhibition, academic posters and students’ inquiry projects were widely disseminated among educators, learners and citizens” (Exhibit: Agrobiodiversity) 16/11/2015.

The other skills described by the ENGAGE project, such as: estimate risks, analyse patterns, draw conclusions and critique claims were not visible in the Brazilian initiatives due to the tasks selected by the educators and the time available to develop the project. However, the research team and educators are planning to extend the project for the next term and include tasks to cover the ten skills with other OER available in the ENGAGE website.

FINAL REMARKS

This study is timely since Responsible Research and Innovation (RRI) for equipping teachers and learners has become more important and there is a lack of studies in this field. Although there are various RRI projects funded by the European Commission, such as ENGAGE (engagingscience.eu), most of these initiatives are recent. Further research will be necessary, especially on the learning outcomes and inclusion approach to promote digital and scientific literacy (Ratcliffe, 2003).

Previous research (Kikis-Papadaskis&Chaimala, 2015) shows various barriers and challenges for teachers to innovate in RRI teaching in Europe. By discussing together both the ENGAGE framework for teachers’ CPD, which considers those challenges, as well as strategies suggested by the teachers of the ENGAGE community, we hope to find practical ways of approaching the initial key issues in this area: How could teachers start their teaching innovation with RRI and inquiry based learning? What might be the initial effect of teaching innovation through dilemma and group discussion on students' learning (Smith et al., 2005)? What are the next challenges for ENGAGE CoP of innovative teachers (Hoban, 2002)?

Our findings related to one month of the three ENGAGE initiatives in Brazil are encouraging and the lessons learned might be useful in Europe. The outcomes and impact will also benefit both countries.As part of the legacy plan, the resources produced and translated into Portuguese will be used in Portugal and other Portuguese-speaking countries. Even though initiatives were developed in a short period of time, participants' comments show various strategies about how to innovate in formal or informal learning with ENGAGE OER and its pedagogical tools for dilemma and group discussion. They also mentioned challenges and recommendations to overcome their difficulties. The next stage of our work is to translate and localise the ENGAGE online courses (MOOC) in Brazil, which initiative will be coordinated by the COLEARN research network. Our next investigation will also focus on the uses of problem-based solution materials and argumentative conversation tools. If ENGAGE CoP in Brazil can be fostered successfully, this might help a higher number of teachers to reach a transformation phase, therefore, it will be possible to find new ways to address the problem outlined at the beginning of this paper - how to use OER on RRI for equipping the next generation for responsible citizenship at scale.

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