

## **Responsible Research and Innovation: an opportunity to develop creative skills at Higher Education**

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### ***Abstract***

*During the last decades, research and innovation have experienced a revolution that has lead to new challenge, and creativity has been identified as a main skill for professional success. In this context, not only concerns about involving society in research and innovation processes have been increasing but also to make this process responsible. Responsible Research and Innovation (RRI) has been defined as the approach for making research and innovation a collaborative, intergenerational and democratic process. The HEIRRI project aims to integrate RRI at all stages of education with the creation of different programs in Higher Eduaction. The aim of this study is assess how creativity has been developed in an RRI framework in the HEIRRI Summer School programme troughout an Inquiry-Based Learning (IBL) approach. On the basis of the results, this paper highlights that the IBL approach, but also the RRI framework foster creativity development in a research proposal design but also that have an impact on how researchers' perceive their profession. This paper concludes that integral elements of this pedagogical approach and RRI, such as discussion, multidisciplinary and including different voices and perspectives are main ingredients to promote creativity in research and innovation processes and have a transformative potential.*

**Keywords:** *Responsible Research and Innovation, Creativity, Inquiry-Based Learning, Multidisciplinary, HEIRRI project.*

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## **1. Introduction**

During the late 20th and 21st centuries, research and innovation have experienced a revolution that has had an impact on human development. New challenges have emerged, and to deal with them some skills have become an urgent need. Creativity has been identified as one of the main and needed skills for professional success and adaptability to constant changing environment.

Creativity is an integral property of research and innovation processes. Researchers are challenged create knowledge as new experts: new questions, deductive and inductive reasoning and combination of unrelated knowledge are properties of this process closely linked to creativity (Barrow, 2010). Although creativity has been always identified as the ability of individuals to generate new ideas, in fact, it is considered as the interaction between aptitude, process and environment where a group of individuals produce something new and useful in a social context (Plucker *et al.*, 2004). Creativity is defined as a social and collaborative phenomenon that requires interaction and discussion (Hadzigeorgiou *et al.*, 2012). Creative thinking a social phenomenon involving interactions among people; it's a property of social groups (Sawyer, 2006).

This global revolution has lead, not only to the crucial development of creativity in research, but also to foster research and innovation processes aligned to the societal need and values, to involve society in the process of decision taking about how research has to be developed. After the Second World War, countries stopped needing military equipment and research started thinking about what society really required to produce reliable knowledge. To that end, not only research had to speak to society, this communication was compelled to be bidirectional (Gibbons, 1999). In recent years, not only concerns about involving society in research and innovation processes have been increasing, but also to make these processes responsible. This movement of responsibility, called Responsible Research and Innovation (RRI), has been defined by Stilgoe *et al.* (2013) as “(...) *taking care of the future through collective stewardship of science and innovation in the present*”. Approaches to responsible innovation extended the governance discussion to encompass questions of uncertainty, purposes, motivations, social and political constitutions and directions of innovation. In this framework four dimensions of responsibility were proposed: anticipation, reflexivity, inclusion and responsiveness (Stilgoe *et al.*, 2013).

In this context, research has lead to new models for collaborative research at large scale (Esparza & Yamada, 2007). It has become a driver for innovation and academic research has participated in large and collaborative big science projects, characterized by multidisciplinary teams (Vermeulen, 2010). This kind of projects collect members of different domains to work collaboratively to make discoveries that impact knowledge, future education and healthcare (Oandasan & Reeves, 2009). Big Science has become an

important way to harness researchers' creativity and enhance innovation through collaboration, multidisciplinary and group thinking, but also an essential scenario of promoting responsible research and innovation (Esparza & Yamada, 2007).

The Higher Education Institutions & Responsible Research and Innovation (HEIRRI) is a Horizon 2020 project that aims to integrate the concept of RRI at all stages of education of scientists and engineers, as well as other fields working on or affected by R&I.

Inquiry-based learning (IBL) is one of the pedagogical approaches used in the HEIRRI project to teach RRI, as well as fostering collaborative creativity. The IBL approach models the general process of investigation that scientists use to answer questions in the real world. It allows students to learn different skills, to apply knowledge and find a solution to a complex problem (Savery, 2006). It simulates real investigations to make students learn while practicing important creative skills such as problem-solving, collaboration, autonomy, considering alternative solutions, investigating different scenarios and exploring new questions (Hämäläinen & Vähäsantanen, 2011; Tan et al., 2009). To foster creativity, many techniques can be developed, such as stimulatory techniques (brainstorming or mind mapping), problem-solving techniques or expert facilitation techniques (Adams *et al.*, 2009). Furthermore, working with multidisciplinary groups can also enhance creative ideas due to the existence of different points of view and the possibility to share a large variability of experiences (Adams *et al.*, 2009).

The HEIRRI project has developed ten different programs to introduce RRI in Higher Education through active learning methodologies. One of the programs, the Summer School, which used the IBL approach, congregated participants from different fields who had to develop a research proposal incorporating the RRI perspective. In this paper, we analyze how the participants of the HEIRRI Summer School have developed creativity in an RRI framework throughout the IBL approach and its transformative potential.

## **2. Materials and Methods**

### ***2.1. Participants***

This study was run at Pompeu Fabra University (UPF) during the HEIRRI Summer School on September 2017. There were 15 participants with different research experiences (PhD students, faculty and senior research staff, research managers, administration and services staff, etc.) enrolled in this program. The participants came from different disciplines such as experimental sciences, political sciences, humanities and translation and interpretation, for example. In this course, 13 participants were female and 2 participants were male. Despite the sample isn't gender balanced, no gender statistical differences have been found.

## **2.2. Study design and setting**

The HEIRRI project has developed different training programs to integrate the concept of RRI at different stages of the Higher Education Institutions. One of the programs, implemented in Pompeu Fabra University (UPF), has been carried out as a Summer School to integrate in the everyday practice and foster reflection on RRI for different staff of the university. The Inquiry-Based Learning approach was used to integrate RRI in a practical way to propose a solution for a complex and transversal scenario: Ageing. The Summer School was performed during four days, in which 5 sessions of 4 hours took place. Different activities were integrated in the framework of the IBL approach.

**Table 1. Summer School course activities overview.**

	<b>Activities</b>	<b>Description of the activities</b>
<b>Day 1</b>	Brainstorming	The participants had to design a multidisciplinary research proposal from a transdisciplinary scenario, ageing, and had to incorporate the basic RRI dimensions.
<b>Day 2</b>	Jigsaw activity	The participants discussed the RRI key issues in small groups with an expert on the field. They had to apply the discussed issues to the research project proposal.
	Walkshop	The participants shared their reflections on RRI and on the research projects in a distended context walking around the city.
<b>Day 3</b>	Museum activity	The participants performed a science café to involve the affected and involved stakeholders' point of view on the research proposal.
<b>Day 4</b>	RRI-project presentations	The participants presented their proposals and discussed how RRI can be included to a research project.

## **2.3. Data collection and analysis**

In this study we examined the development of creative skills throughout the implementation of the IBL approach at the HEIRRI Summer School within an RRI framework. The study has the ethical approval from the UPF and the informed consent of all the participants.

The empirical data was collected through a questionnaire solicited at the end-of-course, that were provided to the research team in an anonymous form. The analysis included all the

responses related to the course. The questionnaire was analyzed through qualitative and quantitative methodologies.

### 3. Results

To analyse how creativity has been developed in an RRI framework throughout the IBL approach and if this pedagogical approach has a transformative quality. The quantitative and qualitative results of the questionnaire have been analysed.

**Table 2. Quantitative results of the questionnaire from 1 (strongly disagree) to 7 (strongly agree) (n=10).**

Questions	Mean	SD	Mode
The inquiry based methodology proposed in the Summer School fosters the development of creativity in a research proposal design.	6.40	0.84	7
The Ageing context may interest different disciplines.	6.70	0.48	7
The openness of the Ageing context facilitates the creation of ideas from different disciplines.	6.40	0.97	7
The Ageing context can be related to your own research line.	4.50	2.07	6
The Ageing context can be related to your own experiences.	5.40	1.95	7
Collaboration between researchers of different disciplines fosters the generation of the creative ideas.	6.60	1.26	7
Including the RRI perspective in the research project proposal design has favored the development of a more creative project design.	6.22	0.97	7
Including the RRI perspective in the research project proposal design has limited the development of a more creative project design.	1.89	1.36	1
During the course, participants can verbalize their beliefs about science and society relationship.	6,40	1.07	7
During the course, participants can discuss different points of view/perspectives	6.30	1.06	7
During the course, a constructive dialogue is generated giving way to new conceptions.	5.90	1.20	7
During the course, my point of view on the science and society relationship has changed.	5.10	1.73	6

**Table 3. Qualitative results of the questionnaire analysed through categorisation system (n=10).**

<b>Category</b>	<b>Sub-category</b>	<b>Further subcategory</b>	<b>Findings</b>
Creativity	IBL pedagogical approach	Scenario	The participants of the summer school state that a global, broad, relevant, shift paradigm scenario that implies emotionally participants can promote creativity development in a research proposal.
		Multi-disciplinarity	Discussion between participants of different fields was very productive. Different perspectives, as well as emotional and personal experiences, makes them think about some points they never thought before, but also to think in a different way and enrich their proposal.
	RRI theoretical framework	RRI integration	Taking into account the RRI perspectives, makes develop more ideas, incorporate new points of view, and anticipate consequences of the developed ideas.
Transformative potential			The RRI perspective, multidisciplinary, including different points of view and rethinking ideas had an impact on how researchers perceive their research.
Limitation			Some activities were more useful than others. However most people regret not having enough time.

#### **4. Discussion**

The findings of this study suggest that the IBL approach had a positive impact on creativity development. As the results show, this pedagogical approach fosters the development of creativity in a research proposal design. Presenting an open and broad scenario that include different disciplines and perspectives can facilitate the creation of new and multidisciplinary ideas. A context which can engage emotionally people can contribute also to this issue. Furthermore, interprofessional groups with people of different fields is seen as a fact of creativity development. Different perspectives and points of view makes

participants' think in a different way and incorporate more original and innovative ideas in a research proposal, but also explore different options, solutions or arguments in a bigger framework or complex situation. Some techniques used during this course also facilitate this process, the science café and the post-it brainstorming are good examples of that. The 100% of the participants considered that the science café fostered the creativity of their research proposal, and the 55,5% that the post-it brainstorming increased too. In fact, creativity is a complex and multifaceted topic, and some studies have identified different factors that contribute to its promotion: improvisation, collaboration, problem-solving, openness and flexibility are essential to creative thinking development (Hämäläinen and Vähäsantanen, 2011). Furthermore, creativity is defined as a property of groups, is a social phenomenon involving interactions among people (Sawyer, 2006). When a working environment brings together individuals from different disciplines and domains and who have different perspectives, the creative potential is enhanced due to different ideas and unexpected connections (Adams *et al.*, 2009). The participants considered with a mean of 6,6 out of 7 that collaboration between researchers of different disciplines fosters the generation of the creative ideas. Some techniques are positive to increase this phenomenon in idea generation and evaluation steps; stimulatory techniques that promote alternative thinking or interaction enhance creative thinking (Adams *et al.*, 2009).

Furthermore, the results also show that not just the pedagogical approach fosters creativity but also the theoretical framework in within the Summer School was developed. Including the RRI perspective into research proposal design made participants think in a deeper way and develop more their ideas, inspect other points of view, analyse information in a different perspective, include different voices and take into account perceptions that they hadn't think before. RRI seeks to bring issues related to research and innovation into the open, to anticipate their consequences and to involve society in discussing how science and technology can help create the kind of world and society we want for generations to come (Smyranio *et al.*, 2017). The four dimensions of responsibility provides a framework for raising, discussing and responding a set of questions that arise from public dialogues on science and public concerns (Stilgoe *et al.*, 2103). This discussion between different stakeholders with different backgrounds but also different perspectives of how research and innovation has to be performed is a theoretical framework that can contribute to creative thinking enhancement, if there is enough time to discuss and reflect.

Finally, this course has become an open and safe environment where the participants could verbalise their beliefs about science and society, discuss different perspectives and generate a constructive dialogue about all the treated issues, but also has been useful to change researchers preconceptions about science and society and had an impact on how researchers perceive their profession and research field.

## 5. Conclusions

Integral elements of the Inquiry-Based Learning approach, but also from the RRI movement, such as discussion on open and flexible contexts, multidisciplinary and including different voices and perspectives are main ingredients to promote creativity in research and innovation processes. Furthermore, this experience had a positive impact on how the professionals perceive their profession and its influence on society.

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