OPENING DOORS

Opportunities and education in networked innovation for new graduates with PhDs using open online resources

Science with and for Society in Horizon 2020
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Policy Brief

Deliverable 4.6

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Table of Contents

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List of Abbreviations

WP	Work Package
BMOOC	Blended Massive Open Online Course
EUA-CDE	European University Association Council for Doctoral Education
ICT	Information and Communication Technology

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List of Figures

This project has received funding from the European Union’s Horizon 2020 Science with and for Society programme under grant agreement no. 101006514

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Executive Summary

This document presents a Policy Brief which includes a problem statement, a summary of the project's main activities and findings; current policies; and policy implications and recommendations. This deliverable (4.6) is informed by D3.2 Opening Doors Student Evaluation Report and D3.3 Opening Doors Report on the career development of students who completed the "Opening Your Research to Collaborative Futures" course. Several recommendations are provided with respect to training and education in open science.

Introduction

The status and journeys of doctoral candidates differ significantly throughout Europe with in terms of institutional structures, admission and evaluation criteria and funding across faculties or disciplines. They are often focused on context specific knowledge, attitudes and skills (EUA-CDE, 2019). However, their role in creating new knowledge, being mobile between regions, sectors, disciplines, and receiving institutional support through structured curricula and supplemental training activities in transversal skills, is seen to be broadly similar. A recent survey by EUA-CDE emphasizes the continuing diverse approaches that universities and higher education institutions in Europe follow in developing their doctoral education. Some universities seem to be focused on increasing the number of doctoral students, some improving doctoral career development and others introducing Open Science as a reality in doctoral studies (EUA-CDE, 2019 p. 33).

Overview of Challenges in Fostering High Skilled Knowledge Workers with PhDs

PhD education is being critiqued now more than ever in terms of its individual, social, financial, educational/pedagogical and methodological value. In addition, over the past two decades, there have been several government papers and policy reports globally that discuss the need to advance a) the number of registered PhD and post-doctoral researchers, b) the diversity and multi-dimensionality of their research degrees by improving the formal doctoral curriculum focusing on PhD supervision and c) their transferable employability attributes identified as generic and (or) professional, practiced through their formal doctorate programme. The idea is that we are provided with highly skilled workers that can add-value to the non-academic sector. However, the vision of highly educated doctoral and post-doctoral researchers employed outside academia is hindered by elevated attrition rates and employability skills gaps reported in career preparedness outside academic settings (Roberts, 2002). Consequently, this has led to research into this employability skills gaps and the identification of these transferable skills for integration into the doctorate curriculum (Gibbs and Griffin, 2013). It is thought that research skills resulting directly from working on a PhD research project alone are not sufficient for working in other employment settings, and that more emphasis is needed on so called "soft" skills (Nerad and Heggelund, 2008 cited in Schaffarczyk and Connell 2012 p. 112) which are not always well-developed in traditional PhD curricula where a research may

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be working solely on their project, in isolation. Davidson says, that "*these skills may be present on commencement, or [should be] explicitly taught, or developed during the course of the research. It is expected that different mechanisms will be used to support learning as appropriate, including self-direction, supervisor support and mentoring, departmental support, workshops, conferences, elective training courses, formally assessed courses and informal opportunities (Research Councils' Training Requirements for PhD students cited in Davidson, 2007 p. 1187)*

Hancock and Walsh (2016) indicate that work experience within non-academic contexts tends to be critical for PhD and post-doctoral researchers to efficiently develop soft skills that they will need across their life-span. Similarly, various authors have indicated the importance of advancing certain business-related knowledge, attitudes and skills within diverse sciences/disciplines (Vanderford, 2012). Extending those business-associated attributes to a) those exercising expanded research access, transparency, and all-embracing agency (i.e. open science; Beck et al. 2020) and b) openness and partnership in knowledge generation and dissemination outside academic boundaries which is currently attracting worldwide academic and practitioner attention e.g. co-creation between industries, innovation communities of practice, open source software/hardware advancement, crowdsourcing, crowdfunding, IP management for patents and licences and other R&D activities (i.e. open innovation; Chesbrough, 2003). Open science and open innovation might, then, empower higher degree employability and advanced, cross-border knowledge sharing which can be translated in to novel products, technologies and services (European Commission, 2016 p. 11 cited in Teo 2020 p. 12).

Within this expanded research context, the challenge of high-quality doctoral supervision for both academics and graduates appears to be fundamental for doctoral success. It is thereby critical for PhD supervisors to know and use available academic and non-academic support systems and communities of practice to effectively instruct their PhD graduates and post-doctoral researchers how to develop both research-related skills and transferrable skills. Existing PhD supervisor professional and research development planning activities tend to assist academics in their doctoral journey guidance. However, it seems that they may need to be further expanded to explicitly embed open science and open innovation-associated attributes, as new policies are developed every year relating to universities. Responsibilities with respect to open science.

Information and communication technologies (ICT) tools have massively facilitated collaborative, interdisciplinary research and wide communication through research networks. Hutchings (2015) in their study exploring the views of PhD candidates and supervisors on group supervision (both face-to-face or online) concluded that PhD students perceive PhD group supervision as helpful to a) enable activities like sharing data, information regarding data management and facilitated them being focused on the PhD research project, b) developing professionalism and assisting them to work with open-minded academics/researchers, c) developing critical thinking, negotiation and provided them with a safe context to present their research, d) facilitate reflection on their own research with other who are on the same research journey but different stages e) stay motivated to progress with their research objectives based on mutual trust. Limited relevance and poor preparation were seen as detractors from the group experience, while remote, online group discussion was indicated as helpful by both PhD candidates and supervisors. Collaborative, web sharing of documents, remote access options and both synchronous and asynchronous modes of interaction were reported as favourable web choices during doctorate group supervision. The technical challenges potentially emerging throughout PhD group supervision online sessions and limited interpersonal cues in remote

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against face-to-face discussions were further indicated as hindering features during doctorate group supervision.

This background literature leaves us with some questions as to how best to facilitate a PhD researcher's journey to safeguard their future career and indeed to safeguard our future society. What kind of curriculum, and what kind of learning environments and activities should be designed to optimise this complex learning experience and supervisor-researcher relationship? Where does the responsibility of open science lie with respect to the institution, the department, the supervisor or the researcher? How can this be taught and how does open science map on to transferable skills training for PhD researchers?

Existing Policies

OpenAire's "Model Policy for Research Performing Institutions" which was created as part of their "Toolkit for Policy Makers", references and draws on many existing policy documents to guide its design. It seeks to align institutional policies with:

> *"the 2012 Recommendation of the European Commission on access to and preservation of scientific information and its 2018 update, the Horizon 2020 Guidelines on the rules of open access to scientific publications and research data, the Proposal for a Regulation of the European Parliament and the Council establishing Horizon Europe- the framework programme for Research and Innovation, laying down its rules for participation and dissemination (COM/2018/435 final) and the Proposal for a Decision of the European Parliament and of the Council on establishing the specific programme implementing Horizon Europe- the Framework Programme for Research and Innovation (COM/2018/436 final) and takes into consideration important developments at EU-level related to Open Science/ Open Access such as the 2016 European Council Conclusions on the transition towards an Open Science system, the "Plan S" and "cOAlition S", the developments of the European Open Science Cloud (EOSC) and in particular the EOSC Strategic Research and Innovation Agenda, the action lines of the European Open Science Policy Platform, the Communication "A new ERA for Research and Innovation" and the 2019 EU Directive on open data and the re-use of public sector information, the Report "Towards a 2030 Vision on the Future of Universities in Europe". In addition, the document also takes into consideration other related reports from university associations like EUA's "Perspectives on the new European Research Area from the university sector" and "Universities without walls: A vision for 2030", the Guild of European research intensive universities "Looking to the Future: the Guild's Vision for Europe's Universities" and other associations like the Science Europe practical guide to the "International Alignment of Research Data Management" ".*

In introducing the responsibilities of research performing organisations, the very first point that is stated is that transition to Open Access/ Open Science through education, training and awareness-raising actions targeting researchers and other employees should be supported, and that acquisition of Open Science and related skills should form an integral part of professional training and career development offered to researchers. In their section dedicated to "Training", they state that training courses for research students and supervisors should include skills necessary for open access publishing, FAIR and open data and data management, research integrity, reproducibility and open science; they should be embedded into PhD

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curricula and tailored to different disciplines. However, there is little guidance on how to create these complex learning opportunities.

Insights and Learning Outcomes from the "Opening Doors" Research Project

Our consortium undertook skills intelligence work with respect to Open Innovation in Science through an exploration of the nature and demands for such skills according to PhD graduates, doctoral educators and industry employees working in open innovation networks. Stakeholder interviews were supplemented with extensive analysis of job advertisements at PhD level and provision of PhD courses in Ireland, Denmark and Czech Republic (WP1.1 and WP1.2). We also undertook a co-design "World Café" event with similar stakeholder groups to define learning outcomes for a PhD level training course in open science and open innovation, which was later validated by industry partners in Ireland and Czech Republic (WP2.1 and WP2.2). We integrated multidisciplinary research evidence and best practice in teaching and learning approaches used within tertiary education to develop the teaching and learning approaches for the open, online course, which was entitled, "Opening Your Research for Collaborative Futures". We also investigated PhD supervisors' needs through stakeholder engagement with respect to supporting PhD researchers in their open science skill development. Finally, we delivered the course over an intensive 6-week period.

Open Innovation in Science Skills Intelligence Profiles

Five skill profiles of PhD graduates were identified:

1) Collaborative and interdisciplinary research – ability to create a collaborative network consisting of researchers and other professionals with various backgrounds, awareness of different expectations.
2) Practical applicability of research results – identifying users of research outputs, goal-oriented approach to research, seeking practical experiences during a PhD.
3) Involving wider public in research – realizing a value of research for society, explaining research to non-experts, defending the need for funding.
4) Use of open science tools – considering benefits of open access publishing of data, code or outputs, ability to find and use available open data, creating open education resources.
5) Career planning – considering future career options early enough during a PhD study, realizing of own skills, acquired during a PhD, ability to see them in outside a research project topic.

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Curriculum Co-Design World Café Event Workshop

Through several rounds of discussion, the 21 Irish, Danish and Czech workshop participants captured how best to design and develop an online educational course for PhD students and post-doctoral researchers in open science and open innovation. Their insights resulted in the following learning objectives:

Learning Objectives of "Opening Your Research to Collaborative Futures"

1. Build awareness of and practice using open innovation frameworks and tools to facilitate co-creation and innovative thinking with stakeholders to increase societal value.
2. Design and implement collaborative projects with other researchers (from different sectors, disciplines and geographies), industry or community groups, understanding the importance of process as well as outcomes.
3. Communicate and open your research up to a variety of international stakeholders including researchers from other disciplines, community organizations, governments, businesses, and civil society.
4. Articulate and explain your knowledge, worldview, methodologies and research goals and be able to respectfully engage on this topic across sectoral and disciplinary boundaries.
5. Build awareness of, and practice using, a selection of open science tools and approaches including ethical considerations such as research integrity and data management.
6. Create a plan for professional development and the development of a professional network to open up traditional and non traditional career paths that align to your values, talents and interests.

It was clear that this course needed to be comprehensive if it was to address these learning objectives. A 10-credit course was developed, with group and individual assessments driven by personal choice, synchronous and asynchronous learning, through lectures, tutorials, personl and group reflections and peer learning.

Multi-level Teaching and Learning Approaches used in "Opening Your Research to Collaborative Futures"

Flipped learning provided course learners with the (online interactive) material to gain active subject knowledge and understanding *before classroom* time that can foster deeper learning and higher order cognitive skill development supplemented by peer instruction (Crouch and Mazur, 2001 p. 970). Course participants were empowered by course facilitators to self-directed and 21st-century learning (e.g. digital literacies). *Challenge-based* collaborative hands-on learning to solve real-world problems was leveraging through the bespoke, online

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course space designed for the project. This involved facilitated by group work to support the engagement with external partners. Students were facilitated to ask good questions of their partners at the right time, develop deeper subject area knowledge, accept and solve challenges, take action, and share experience (Nichols and Cator, 2008 p.1 cited in Leijon et al., 2021 p. 4).

Design Thinking/Systems Thinking learning was implemented within the challenge-based framework. This is best thought of as a system of the following three overlapping spaces: inspiration, ideation, and implementation. The first may be operationalized as the problem or opportunity that motivates the search for solutions; ideation can be thought of the procedure of generating, developing and testing ideas; and finally, implementation, as the stream that leads from the project stage (level) into people's reality (Brown and Wyatt, 2010 p. 33).

Figure 1 "Opening Your Research to Collaborative Futures" Model for Challenge Resolution

Course Participants

Fifty-nine PhD students registered to the course with more on a waiting list. The expectations of the course (e.g. with respect to attendance--2.5 full days a week for the first 3 weeks--and assessment) were clearly reiterated to registrants the week before the course began to ensure that they could make the necessary commitment and if not, they were asked to rescind their place. Very few gave up their registration. However, only half of those registrants fully committed to the course i.e. pursued the 10 credits by submitting all assessment pieces, while the others dipped in and out to whatever interested them. Thirty PhD students of diverse age range, PhD stage, country origin and disciplinary background completed the "Opening your Research to Collaborative Futures" course.

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Student Reflective Blogs About "Opening Your Research to Collaborative Futures"

While detailed information on the course evaluation is available in other project deliverables (D3.2 and D3.3) some reflections from students are provided here:

"*It was interesting to hear other people's perspectives on the Thesis in 3. One person used the idea of a 'hook' on the first slide, to capture the audience's attention. Another person emphasized the importance of the visual impact. A third person spoke about 'taking you on a journey', while another mentioned the 'What, why and how?' of the presentation. My own view was to try and address the idea of 'So what?' – why is my research meaningful and why people should sit up and listen"*- on 'Thesis-in-3' presentations

"Although I certainly felt that I had understood the instructions and guidelines, I kept speaking in a formal language and culture-specific abstractions kept sneaking into my presentations. In fact, it's a little weird. As a long-time lecturer, I have plenty of routine in conveying difficult academic points to students who have grown up without the opportunity to work with more abstract language codes. The experience of gaining relevant interpretations of the meanings of interdisciplinary skills in combination with communicative competencies has become present in an overwhelming and very concrete way. When I read the notes I have made today, it may seem banal that collaborative skills and willingness to learn new things in collaboration with others can stand as results of thorough scientific studies. Yet it has become clear – especially in the short time we have spent presenting ourselves and our individual competencies in the group in which we have to work with 'real-world challenge' – that there are cultural differences. The question now is whether they are in fact valuable differences that can help find new and exciting perspectives and solutions. I'm looking forward to finding out"- on Challenge-based group learning

"The Self-Assessment helped me to reconnect with my interpersonal understanding. This was particularly important for me as I have not seized many opportunities in this area over the last number of months" – on Self-assessment of Open Science understanding and attitudes, intercultural sensitivity, and problem-solving through questionnaires and discussion.

The most significant concept to stick with me to date was "Debate, Discussion and Dialogue". XXX's observations around the generational communication differences, moving through from debate to dialogue, was striking. This is something that I often struggle to find balance in. A question I have is:
How might a "Dialogue Communicator" protect themselves when a dialogue communicator is surrounded by "Debaters" of "Discussers"? – on communication skills and conflict resolution

Policy Implications and Recommendations

- Open science is an umbrella term that encompasses many facets of research practice, including open innovation. However, these terms are not well understood by people outside of these specific fields. Clear definitions and examples that are relevant to all PhD stages are needed.

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- Self-assessment of baseline skills in open science are important for PhD researchers, but no clear guidance exists on how this can be done. While our study shows that the Orion Questionnaire for Self-Assessment on Open Science is a useful reflective tool, it is not clear what standardised questionnaires could be most useful in this regard. As per the previous point, if clear definitions and examples of open science activities were mapped to skills/competencies, PhD researchers could self-assess in a more meaningful way.
- Communication skills at several levels i.e. skills that enhanced interpersonal relationships; communication within and between scientific disciplines; across sectors; communication of research value and impact, were most valued by the non-academic stakeholders that were interviewed. Thus, open science training should incorporate these aspects as well as the more technical aspects of data sharing, preregistration of studies etc. Interdisciplinary challenge-based learning with external organisations is an excellent way to achieve such learning outcomes.
- The skills profiles that emerged through our stakeholder engagement can be mapped to the ESCO skills and competencies. A skill that was missing and tends not to be discussed enough with respect to open science is the ability to evaluate knowledge and to discern good/bad/useful information. Given that this is currently a huge challenge facing our society, this skill should be to the fore in open science training.
- Most students were motivated by the "for-credit" model. We suggest that training in open science should be for credit.
- A completely online course with emphasis on group work can work well. However, the mode of delivery should be carefully considered e.g. if international, consider time zones, how much asynchronous versus synchronous content to allow for flexibility.
- Providing choice in the assessment tasks undertaken by course participants meant that students were undertaking something that was relevant and beneficial to their research, which they felt was important. Given the broad nature of open science, the learning experience should be as personalised and as practically relevant for students as possible.
- Data management, career development and communication seem to be the most generalisable open science learning needs
- Training in open science should be guided by pedagogical frameworks / theories e.g. Flipped Classroom, Challenge-based Learning, Design/Systems Thinking; Self-Determination Theory, Project Management Principles--with multiple learning and teaching activities e.g. self-assessment, scaffolding, peer learning, reflections, facilitation, debate, authentic sharing by all.
- Similar to the ability to establish a baseline in open science skills, it is important to create guidelines on how to evaluate such training. What does success look like?
- A whole-university approach is needed for open science skills training that encompasses training for supervisors as well and PhD researchers, with relevant institutional information packaged up / mapped with respect to intellect property supports/information, local data sharing policies, repositories, open source communities etc
- Participatory research methods such as co-design and stakeholder engagement are key to understanding local/national/international contexts to optimise open science and open innovation practices across communities

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