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TRANSFORMING OPEN RESPONSIBLE RESEARCH AND INNOVATION THROUGH CHARM
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EXECUTIVE SUMMARY: BALANCING EXCELLENCE-DRIVEN RESEARCH AND TRANSDISCIPLINARY RESEARCH AND PUBLIC ENGAGEMENT REPORT

The objective of this report is to present the results from the TORCH project WP7 research on public engagement and transdisciplinary science (research and education). This report is the follow-up from the D7.1 report, which has presented the collection of experiences and good practices on incentives and disincentives for public engagement and transdisciplinary science. In this report (D7.2), we present the findings from the operationalization of Task 7.2: Reflections and recommendations for future transdisciplinary research and innovation to balance excellence-driven and global challenge-driven science. The main results contain broader analyses and recommendations for transdisciplinary research and innovation to balance excellence-driven and global challenge-driven science.

The result of our research shows that systematic empirical studies of how public engagement and transdisciplinary science have been perceived and manifested in different universities are valuable but also still lacking to some extent. We found that public engagement, transdisciplinary science, and democratization of science have different meanings for different universities. Therefore, understanding the concepts used and underlying contexts that relate to socio-cultural and political systems surrounding science and university systems, is crucial for the university to come up with a joint focus and goals in developing their public engagement and transdisciplinary science vision. Furthermore, it is also clear from our findings that public engagement and transdisciplinary science are much connected to the overall vision of furthering open science, as it helps to position science in the larger role to connect science with society and embrace the universities' role in actively addressing sustainability problems. To move forward with the open science agenda, the improvement of a rewards and recognition system for public engagement and transdisciplinary science is pivotal, as the system could provide incentives to individual/team level and trigger more actors to start doing public engagement and transdisciplinary science. Furthermore, increasing capacity has also proven to be important, as often, both scientists and societal stakeholders have limited time, funding, and skills to engage the public/conduct a transdisciplinary approach.

Our findings echo the often-used adage that 'open science' is an essential building block of open societies. When WP7 started, the term "democratisation of science" was used in this respect. However, based on the findings we advise against using this term and argue that it should be revisited as it is prone to misunderstandings such as suggesting that public voting would determine the credibility of science and scientific truth. The term "democratisation by science" is deemed more adequate as it puts the objective forward, i.e., using science as evidence for determining appropriate public policy to solve societal challenges, and therefore to democratise society. This debate should be continued further along the road to promote open science. The latter involves striking a delicate balance. On the one hand, scientific freedom and independence must be maintained and space for blue skies research ensured. On the other hand, open science in an open society requires science to be also mission-oriented and to pursue further on the path towards more public engagement. In addition to the role of universities to explore ways to engage more public and conduct

transdisciplinary science, universities should also lead the effort in finding the right balance in providing spaces for a wider range of engagements. Finally, there is a great demand for universities to take a more prominent role to bridge science with the marginalized and disadvantaged citizens to contribute to leaving no one behind; becoming a testbed for innovation on public engagement and transdisciplinary science and actively promoting the open science agenda in different avenues. We argue that diversity and inclusiveness should be on top of the agenda in strengthening public engagement and transdisciplinary science as part of the wider open science movement. These steps would help accelerate the effort to balance excellence-driven science and public engagement and transdisciplinary science.

1. INTRODUCTION

1.1 Objectives, corresponding tasks, and deliverables

This report is aimed to fulfil the second objective of TORCH WP7's work, i.e., to collect and share existing practices to balance between mono-disciplinary, excellence-driven research and global challenge-driven transdisciplinary research and innovation. This report (D7.2) reflects on the achievement of existing modalities and practices for stimulating the co-creation of challenge-driven research and innovation with societal stakeholders and to further "democratisation of science" and provide recommendations on balancing excellence-driven and global challenges-driven science.

To achieve objective 7.2, two sub-tasks tasks have been conducted in parallel:

Task 7.2.1 Existing experiences: balancing of mono-disciplinary and transdisciplinary science (M1 January 2021- M10 October 2021)

Task 7.2.2 Best practices: balancing of mono-disciplinary and transdisciplinary science (M1 January 2021- M10 October 2021)

We focused on the identification of the most workable incentive mechanisms and modalities to address different barriers and (ethical) dilemmas. We identified the most decisive types of incentives in stimulating transdisciplinary science. We also placed our findings (from the good practices we collected in Task 7.1) in a larger debate on open science and the role of the European universities in promoting open science and to further democratising science. Finally, this report presents higher-level reflections and recommendations on how to balance excellence-driven research and global challenge-driven science. Recommendations will be targeted to individual/team level, (European) universities and European university alliances level, funding agencies, the European Commission and EU member states, with a focus on the countries where the partner institutions are located. These recommendations are based on the analyses of each of the university actors' roles in advancing excellence-driven research and transdisciplinary research and public engagement.

This report is structured as follows: In section 1, we outline the introduction which includes the scope, objective of the report. In section 2, we then present the result of task 7.2.1, and provide the reflections from the university-level findings, focusing on the existing experiences on balancing mono-disciplinary and transdisciplinary science (See also D7.1 report) and section 3 presents the result of task 7.2.2 on forward-looking best practices on balancing of mono-disciplinary and transdisciplinary science. This last section will focus on higher-level abstractions, on how the university-level findings contribute to the debate on open science, the democratisation of science, future university roles and recommendations.

2. Existing Experiences: Balancing of Mono-Disciplinary and Transdisciplinary Science

The existing experiences of universities are described in terms of 1) how public engagement and transdisciplinary science are interpreted by different universities; 2) existing university structures and policies promoting public engagement, transdisciplinary science, and democratisation of science; 3) reflections on novel practices and 4) reflection on incentives and disincentives at the different levels.

2.1 Various definitions of public engagement and transdisciplinary science

According to our empirical results, there are various ways in which public engagement and transdisciplinary science are defined and interpreted. These definitions and interpretations are largely informed by different scientific fields, schools of thought, institutional perspectives, and socio-cultural and political positioning of individuals/institutions/systems. In this section, we will only present a commonly accepted definition mentioned by selected university policies/majority of interviewees and experts who participated in the TORCH WP7 research conducted in each partner university. Only two out of five universities presented explicit definitions of public engagement and transdisciplinary science, i.e., UU and UM.

UU defines public engagement as a two-way process, involving interaction and listening, to generate mutual benefit. Public engagement is seen as the most common terminology as it reflects the broader engagement of the public in science[1], which could include science communication, dissemination, patient involvement, citizen science, stakeholder engagement, etc. Meanwhile, the term transdisciplinary science is not widely used by all faculties/institutions within the university. One of the institutions using this terminology is an inter-faculty research programme called Pathways to Sustainability. They define transdisciplinary science as "engaging stakeholders in significant ways throughout the research process, rather than collecting data, informing stakeholders or valorising knowledge afterwards"[2]. This is in line with prominent definitions in the literature of the concept of transdisciplinarity. These definitions converge in that they assume that transdisciplinary research simultaneously works on scientific and societal progress (see e.g. Pohl, 2008[3]).

UM interprets public engagement as an effort to move towards a co-construction. Co-construction must be conducted in every stage of the research: co-constructing with the citizens and civil society, co-defining the conditions for the construction and implementation of research programmes, co-defining the research questions and scientific protocols with the citizens, co-creation of common challenges and finally co-defining the methods of dissemination of results, plus co-construction of the data. Public engagement should allow citizens and researchers to co-construct with the political

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[1] https://www.uu.nl/en/organisation/public-engagement-at-utrecht-university/what-is-public-engagement
[2] https://www.uu.nl/en/research/transdisciplinary-field-guide/get-started/what-is-transdisciplinary-research
[3] Pohl, C. (2008). From science to policy through transdisciplinary research. Environmental science & policy, 11(1), 46-53.

field: influence policy decisions on research, priorities and budget allocation, for instance, programming of scientific priorities.

TCD uses several relevant terminologies with public engagement, including engagement with society, i.e., civic actions, open scholarship, engaged research. The strategic plan of TCD highlights Community and Connection' in its title. It reflects the conviction that, in an increasingly interdependent world, we need to work together more intensely and in new ways to address the formidable challenges facing us. Civic action is also one of TCD's CORE visions, enhancing civic activities through teaching, research and public engagement, TCD courageously advances the cause of a pluralistic, just and sustainable society. Trinity's Research Charter[4] presents the core principles that are central to TCD's research philosophy and actions. Under Principle 6 of TCD's research charter, recognition of public engagement is highlighted: "Increasingly, it is about recognising that our different publics can be research collaborators – active participants and co-creators – in our research, and therefore it means acquiring the communication skills to work at this deeper level of two-way engagement."[5] The Charter also recognises that engagement is not just about dissemination but also about the two-way flow of ideas, with the potential to guide research through gaining insight into public concerns, and through offering new ways to collaborate. Trinity recognizes the need to be at the forefront of new forms of research collaborations with its public and recognises this as an essential part of building and maintaining its reputation nationally and internationally"[6]. At Trinity College, "Open Scholarship"[7] is defined as the practice of research, education and knowledge exchange in such a way that others can collaborate and contribute, where research publications, data, lab notes and other scholarly processes and works are properly and ethically managed and evaluated and, unless restricted for justifiable reasons, are freely available to all levels of society under terms that enable reuse, redistribution and reproduction of the work and its underlying data and methods.[8] The term engaged research is also promoted by Campus engage[9], the Irish Universities Association, of which TCD is part. Engaged research showcases the connection between higher education and society, to demonstrate island-wide commitment to building on what has been achieved to date and place Ireland at the fore internationally in terms of promoting civic and community engagement in higher education.

Our findings showed that, overall, public engagement is a more accepted terminology, as it represents a wide range of stages and ways to engage societal stakeholders. From the disciplinary perspectives, diverse terminologies relevant to public engagement and transdisciplinary science exist (e.g., patient care for the medical field, responsible innovation for innovation studies). Meanwhile, other terminologies used in a broader spectrum are stakeholder engagement, citizen

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[4] Trinity College Dublin, the University of Dublin, Research Charter:
https://www.tcd.ie/research/about/charter/
[5] Trinity College Dublin, the University of Dublin, Research Charter, p. 13.
[6] Trinity College Dublin, the University of Dublin, Research Charter, p. 13.
[7] Trinity's Open Scholarship: https://libguides.tcd.ie/open-scholarship
[8] Adapted from the Open Science Definition: https://www.fosteropenscience.eu/taxonomy/term/100
[9] Campus Engage, Irish Universities Association: https://www.campusengage.ie/

science, science communication, co-production[10,11], and co-creation. Currently, there is no commonly agreed understanding on key definitions and explicit connections between public engagement under the open science paradigm.

2.2 University structures and policies

Public engagement and transdisciplinary science are crucial elements of open science. Therefore, it is important to ensure that public engagement and transdisciplinary science are embedded within the structure and policies of the universities. The five participating universities have different ways of embedding public engagement and transdisciplinary science in their structures and policy. For instance, UU has a specific, centralised, policy and structure on open science and public engagement. These are manifested in UU's strategic plans 2021-2025, open science programme and pillars, including the rewards and recognition, public engagement, fair data and software, open access and open education pillars, multidisciplinary strategic themes and a dedicated public engagement unit as part of the UU's central offices (Universitaire Bestuursdienst) - the Centre for Science Communication and Culture (CWC), a dedicated professorship position on public engagement, inter/transdisciplinary courses in the Bachelor's and Master's programmes, the establishment of the dedicated position supporting public engagement and open science. Besides the centralised policy, equally important are the initiatives taken at the individual/team, programme group, department, and faculty level. These are considered as the bottom-up initiatives that drive open science, including public engagement and transdisciplinary science agenda further.

For the other four universities (ELTE, TCD, UB, and UM), public engagement and transdisciplinary science are highlighted as one of the focus elements, either in their strategic plans, or units, centres, team/individual research projects within the university. For example, in ELTE, the third mission strategy is planned to be created within the timeframe of the Institutional Development Plan 2021-2024. The goal is to strengthen embeddedness in the local/regional/national ecosystem through diverse contributions to address pressing social and economic needs and challenges. In addition, in ELTE, there are also existing structures that carry public engagement and transdisciplinary science-related tasks: the Rector's Cabinet Science Policy Office (SPO) and the Rector's Cabinet University Strategy Office (USO). The relevant mandate of SPO is to mainstream open science, while the USO is responsible for the development of the third mission: to initiate, coordinate as well as monitor complex projects as well as inter-and multidisciplinary activities on a national and international level that require cooperation both across the University's faculties and beyond academia: with the public and business sectors. UM has also similar structures in place at the level of the university, i.e., Vice-President for "Science and Society".

At TCD, Trinity College Dublin's Strategic Plan 2020-2025 highlights civic action as the first of its "CORE" principles, committing to "courageously advance the cause of a pluralistic, just and

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[10] Armitage D et al. 2011. Co-management and the co-production of knowledge. Learning to adapt in Canada's Arctic. Global Environmental Change 21(3):995-1004.

[11] Van der Hel, S. 2016. New science for global sustainability? The institutionalisation of knowledge co-production in Future Earth.

sustainable society" through teaching, research, and public engagement. The important role of a research centre in leveraging public engagement and transdisciplinary science is highlighted in the case of UB and UM. UB developed a centre called the UB's Science and Technology Centres (CCIT-UB) to facilitate mutual learning and collaboration between research groups and citizens. Meanwhile, UM's MUSE (Montpellier University of Excellence) has a crucial role in setting up specific funding for the transdisciplinary proposal.

In conclusion, we see that to a certain extent, all five universities have incorporated the vision of open science into their policies and structures and are committed to conducting public engagement and transdisciplinary science in one way or another. There are different ways to incorporate public engagement and transdisciplinary science into the university structure and policies. They are mostly determined by the existing university system in place. The size and complexity of the university system are perceived as both challenges and opportunities to promote public engagement and transdisciplinary science under the umbrella of open science. On the one hand, the large size and complexity of the university system is a challenge, especially in terms of coordination and synergising actions and cumulating effective knowledge. On the other hand, opportunities arise from the diversity of university actors involved in such (public engagement and transdisciplinary science) initiatives in different levels (university, inter-faculties, faculty, department, programme group/team, and individual level); type of programmes (education, research and interplays), and type of societal stakeholders involved. These types of bottom-up initiatives are important to develop and shape the open science agenda further.

2.3 Novel Practices

There are many initiatives listed as good practices on public engagement and transdisciplinary science. Table 1 summarises a selection of novel practices from different universities (non-exhaustive).

Table 1. Selected list of novel practices (non-exhaustive) based on a different level of incentives

Type of incentives	Selected list of novel practices
Individual	Training and capacity building Transdisciplinary field guide (UU) MUSE training (UM)
University	Open science programme, multidisciplinary themes (UU) Living Labs (TINLAB, ELTE) Inter-, and transdisciplinary educational programme (community service programme, Star-bus Inclusion Intervention Programme, ELTE; UU-Thematic Interdisciplinary Challenge and community-engaged learning, lifelong learning/mixed classroom UU) Dedicated positions on public engagement International projects/consortium (CHARM/TORCH) Rewards and recognition system (TRIPLE/MERIT (UU); Plan for academic dedication (UB))

Societal stakeholders	Citizen science (ALLINTERACT-UB, COASTSNAP UU) Projects that include the younger generations (school kids) (Star-bus inclusion intervention programme at ELTE, La UB divulga at UB); Industry (Sustainable Industry Lab, UU) Involving the marginalized ('Languag-E-Chance', ELTE) Science dissemination (Campus Engage, TCD)
Systemic	Regional and European funding calls (Horizon Europe) National funding calls for open science/stakeholder engagement (The Dutch National Research Agenda, Science Patronage Call, Hungary) Local funding calls (Seed funding UU, MUSE funding, UM)

Targeted at the level of individuals, there are several examples of knowledge platforms, training and capacity-building programmes at different universities. They are instigated at different levels but aim at strengthening the skills of individual researchers, teachers, and students. An example is the existing knowledge platform, Transdisciplinary Field Guide at UU. In Montpellier, MUSE[12] has established training for researchers and academic staff focusing on science dissemination. These initiatives signify good efforts taken by universities to go beyond sharing research with the public, engage society through the co-construction process, starting from inception to dissemination.

At the university level, initiatives are wide-ranging, starting from the structure and policies (see section 2.2) to relevant projects and university-level positions. At the UU, the Open science programme[13] and multidisciplinary themes have been established, which triggered a university-level debate on the relevance of public engagement, open education, and rewards and recognition. Another notable example of rewards and recognition is the plan for academic dedication which will be adopted by UB. The plan includes a section on Dissemination and Knowledge Transfer which can be used to substantiate staff's activities public engagement-related activities, and in the larger context, is expected to help to reverse the mismatch between institutional and individual commitment. They are working on how to measure this activity, considering elements such as science dissemination. In terms of projects, living labs as incubators of innovation have been also established in many universities. For example, ELTE with its National Laboratory for Social Innovation[14] that promotes a quadruple helix of social innovation on eight sustainability-related themes.

Equally important are the educational programmes which introduced and further positioned the importance of public engagement, inter-, and transdisciplinary science. A collective example is the CHARM-EU Master's on global challenges for sustainability, where all five universities are

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[12] https://muse.edu.umontpellier.fr/en/muse-i-site/international/makit-home/

[13] https://www.uu.nl/en/research/open-science

[14] https://www.elte.hu/innovacio/tinlab

participating, ELTE's community service programme and Star-bus inclusion intervention programme and UU's Thematic Interdisciplinary Challenges (TIC).

In terms of funding, there are some examples where universities offer local funding, such as the seed money funding mechanism at UU and the MUSE call for a proposal on transdisciplinary science (UM). At the societal stakeholders' level, several good practices can be highlighted. Citizen science projects can be found in different universities, for example, the EU-ALLINTERACT[15] project at UB and COASTSNAP[16] at UU. Some projects are also involving different layers of society. ELTE (Star-bus Inclusion Intervention Programme[17]) and UB (La UB divulga) for example target the younger generations, UU with its Sustainable Industry Lab which focuses on partnerships with industries among other actors. The Languag-E-Chance project, with the contribution of ELTE researchers, involved the marginalized community (i.e., Roma people, hard of hearing persons).

At the systemic level, most universities have mentioned initiatives related to financial incentives. At the EU, the topic of sustainability is prioritised, and there is a solid mechanism of regional funding calls, such as the EU Horizon 2020 (now Horizon Europe). At the national level, national research agencies also offer mechanisms that invite proposals with public engagement and transdisciplinary elements. An example is the Dutch national research agenda (NWA)[18] and Call for Science Patronage Programme in Hungary.[19]

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[15] https://allinteract.eu
[16] http://www.coastsnap.com/
[17] https://csiip.elte.hu/
[18] https://www.nwo.nl/en/researchprogrammes/dutch-research-agenda-nwa
[19] https://nkfih.gov.hu/english/news-of-the-office/huf1-7-billion-for-the-international-promotion

3. BEST PRACTICES: BALANCING OF MONO-DISCIPLINARY AND TRANSDISCIPLINARY SCIENCE

3.1 Reflections on Transdisciplinary Science and Public Engagement in the Larger Debate on Open Science

The position of public engagement and transdisciplinary science in the larger debate on open science cannot always be distinguished. The findings from our research show that public engagement and transdisciplinary science are key elements of open science.

For UU, public engagement and transdisciplinary science are centrally located at the heart of the open science debate. UU has set open science as a high priority issue on the agenda, through the strategic plan 2021-2025[20], the establishment of open science programme and many other initiatives. UU has also been a champion in promoting the open science agenda, reflected in its new motto: Sharing science, shaping tomorrow. At UU, our findings confirmed that public engagement and transdisciplinary science are centrally located at the heart of the open science programme. The strategic plans of UU, including the establishment of four interfaculty multidisciplinary strategic themes and their hubs, are the structural drivers of public engagement and transdisciplinary science. However, bottom-up initiatives from university actors at all levels also keep the discussion alive and help to further develop visions and ways to make open science feasible at the practical level. The discussion on the position of public engagement and transdisciplinary science cannot be separated from terminologies (around open science, public engagement, and transdisciplinary science) having different meanings to different people, according to their situational and contextual backgrounds (e.g., scientific disciplines, professions, experiences, socio-cultural values).

ELTE shares the Hungarian National Research, Development and Innovation Office's understanding of open science: it means collaborative research processes and a new approach to disseminating results through digital technologies and modern collaborative tools[21]. ELTE believes that open science is a process that benefits researchers, universities, research institutes, industry and society as a whole, and therefore support the development and continuation of multi-stakeholder collaborative research. According to ELTE's apprehension of the third mission, public engagement and transdisciplinary science are among its main areas towards which the University continuously expresses its commitment, among others in the Institutional Development Plan 2021-2024. Accordingly, ELTE acts as consortium leader a/o partner in several National Laboratories: comprehensive, interdisciplinary knowledge centres in certain fields e.g.: artificial intelligence, digital heritage, etc., and also the National Laboratory for Social Innovation (TINLAB), a dedicated partnership of stakeholders from the quadruple helix to foster social innovation. National Laboratories (a Hungarian government-funded initiative) provide participating universities excellent possibilities to disseminate their findings, know-how and best practices between each other, as well as to the public. Also, in such partnerships communication among the partners is more

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[20] https://www.uu.nl/en/organisation/strategic-plan-2025/strategy#5

[21] https://nkfih.gov.hu/hivatalrol/strategia-alkotas/open-science https://nkfih.gov.hu/openscience/position-paper-on-open

straightforward and trustworthy, which facilitates a more effective workflow. In ELTE's experience, when a scientific result has a social contribution, dissemination to the public is easier, enhanced even further by the implementation of open science principles. When the third mission was defined as a new profile of ELTE, it became obvious that it is necessary to create a third mission strategy and action plan (foreseen in the framework of the Institutional Development Plan 2021-2024). In this regard – aiming at reaching the goals systematically – ELTE can be distinguished from most of the other Hungarian and Central European universities. The future strategy and action plan will aim at reaching the public via useful projects such as those mentioned above in D7.1 report, making it possible to involve small groups of – sometimes underprivileged citizens, or even individuals in research projects, fostering social mobility and understanding important principles of science at the same time. While guarding its scientific excellence, ELTE is committed to bringing scientific work closer to extra-academic stakeholders and the general public via various tools and channels.

For TCD, it is clear that while public engagement is being given more priority in national and international funding initiatives, and it is at least being mentioned in university documents, a Civic Engagement Strategy or Action Plan at the university level, which is under development, is lacking. Transdisciplinarity is even less well represented. There are deep-rooted frustrations too, with many feeling that while funding agencies encourage (or sometimes insist on) public engagement, the reasons behind it are not always obvious, with consequences for individual motivations. Oftentimes it seems that it is the personal and professional responsibilities of the researchers and practitioners themselves that it is the strongest influence in public engagement.

According to UB, an engaged university treats transdisciplinary science and public engagement as an integral part of research and invests in infrastructure, processes, and people to bridge the gap between the scientific and non-scientific communities. To achieve such a goal, in general terms, the university should have: a) research and outreach activities that incorporate public participation in its tasks; b) teaching committed to public engagement and transdisciplinary science; c) fluid communicative processes between the scientific community and different sectors of society. As a central point, there must be a recognition by the institution of the value and importance of citizen participation, by including this commitment to the university's open science strategic plan and support strategies (formal and informal). This translates into a shared understanding (individuals and citizens) of the benefits of "citizen science" in both the quality of research and in maximizing its impact. UB is trying to enhance its commitment to horizontal research through innovation. In addition, it plans to build an environment for engagement that is also inclusive.

Meanwhile, UM's findings revealed that the sharing of practices and therefore openness between disciplinary communities is greatly facilitated by open science practices. Moreover, research data, coupled with data science practices, are at the heart of profound transformations in scientific practices. There is a strong axis of open science policies at the UM (see the ExposUM project for the UM[22]). By promoting responsible science, open science contributes to offering citizens the means to appropriate the results of science with greater transparency and to contribute through

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[22] https://www.umontpellier.fr/articles/la-success-story-muse-continue-avec-exposum

participatory science approaches (Science with and for society). In addition, at the UM, practitioners believe that we should reflect on why we are doing public engagement in research; why are we bringing in citizens? is this the right and useful approach? Do we have indicators to measure public engagement? Furthermore, the issue of academic freedom was raised during the experts' workshop. The problem with co-defining research topics/problems is that citizens or politicians place these questions in an ideology and already have preconceived ideas of what the answers should be. In addition, it is important to have mutual respect for citizens and to see that public commitment is not necessarily a trade-off for academic freedom.

3.2 Reflections on the concept of democratisation of science

While inclusivity is considered a crucial principle and one of the main objectives of public engagement and transdisciplinary science, the term democratisation of science is less known and less prominent. Only two of the participating universities use this term. In The Netherlands, only some interviewees with closely related backgrounds were familiar with this term. Those who questioned this term were concerned about the fact that the term implies that science needs to be based on the democratic vote, while that is not implied. The issue of independence and credibility of science then would become a trade-off for the democratization of science. Some experts suggested reformulating the terminology to democratization *by* science, which can arguably be seen as a manifestation of 'open science in and for an open society'. This perspective corresponds with TCD and UM. For TCD, the term "democratisation of science" is not used very commonly among public engagement researchers and practitioners, but the interviewees believed that universities have a key role in promoting open scholarship. The interviewees felt that the public engagement landscape is changing, which is itself a challenge and trying to capture impact can be difficult. For UM, the term "democratisation of science" is somewhat disturbing and not unanimously accepted. It implies that scientific production will be useful to the life of citizens, to contribute to a democratic society. Yet, it is not always the case. The preferred term should be "engaging in civic debate and contributing to democracy".

For UB, democratisation of science means leveraging European universities' role in providing structures and processes that drive and extend reflective pathways related to open science. It is important to highlight that Open Science does not mean only publishing open access or having the data in public repositories following the FAIR criteria. Open science also involves working to open scientific contributions to the whole scientific community and the whole society. Open science can: a) offer support to the different parties involved in the democratization of science (internal or external to the institution), b) improve the quality of research and open science, c) foster innovation and access to co-creation methodologies, d) bridge thinking, and e) monitor research participation and impact. In addition, it can be a key space for a two-way exchange of information and experience between different actors. Thus, generating science that goes beyond conference rooms and laboratories. For ELTE, however, the term democratisation of science resonates with the importance of fact-checking. It cannot be emphasized enough in the 21st century. Positive attitudes to science can be vital for both the individual and society as a whole. Access to information and ways to find

out how reliable it is are equally important. Universities have a key role, and also responsibility, informing public opinion. Although, in theory, promoting democratisation of science gets absolute support from the university, it is still hardly visible in the institution. It is mainly because it is hard to get a grip on the real meaning and usefulness of the concept itself, and researchers and lecturers need a better understanding of how it can be applied in their professional activities. ELTE's goal is to find ways to apply the Institutional Development Plan and other relevant strategies directly in the everyday life of researchers, grabbing their attention and promoting democratisation of science among them, so that they will strive for self-realization. This can, ultimately, also lead to the establishment of firm methodological grounds.

3.3 Reflections on the future role of European universities in promoting open science and to further contributing to a democratic society and sustainability

Our research shows that European universities carry an important role in further contributing to democratic society and sustainability. In addition to its existing mandate to produce knowledge, provide education for the next generations, Universities are now challenged to take an active role in bridging science and society. In the educational domain, for example, the task is not only on education and research but also to provide all students with a general apprehension of science, processes, methods and results. The mindset of open science should not only be relevant to the devoted scientists but all university citizens. In short, we argue that open societies require open science[23]. Promoting open science, and being part of the European university alliance, building on their synergies, exchange of knowledge and good practice can mainstream these values not only in their own country but at the European level. A bidirectional flow of information can provide academics with more insight into the specific local problems whereas the public may be able to view their situation from a broader, more global perspective.

In terms of research, universities have the role to create effective spaces for dialogue between researchers from different disciplines concerning global challenges and involving key stakeholders in the conversations. Furthermore, the development of an international collegial network is vital to foster collaborative and participatory research models, from disciplinary to multi-, inter, and transdisciplinary ways of working. Finally, universities and collaborating organisations should be subject to a constant evaluation process and include these indicators to be aware of progress in the dimensions here discussed; Recognition, funding, and support of this type of research and activity are key in supporting effective and high-quality science. European universities are among the most committed to further promoting open science. It is important to increase awareness of the issues, provide capacity training and technical support environments for researchers and students at all levels and keep being active in international, European and national level discussions on open science, public engagement, and transdisciplinary science.

European university alliances can also take more active roles as testbed universities, to test innovative methods to conduct public engagement and transdisciplinary science. The important

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[23] See also Miedema, F. (2022). Open Science: the Very Idea (p. 247). Springer Nature.

debate within the universities is to what extent they can push the boundaries of open science. The TORCH project contributes to exploring these boundaries. In addition, European University alliances could explore their roles in lobbying both at the national and regional levels. The purpose of the lobbying could be to create more spaces and opportunities for collaboration and innovation in open science, both in terms of research and education.

3.4 Recommendations and future research agenda to further improve transdisciplinary research and innovation to balance excellence-driven and global challenge-driven science

3.4.1 Recommendations

Based on our analysis and findings, we have identified several recommendations targeted to actors at the level of individual, university, and system.

Individual level

· To find alternatives and possible ways to engage the public and conduct research in transdisciplinary ways.

· To increase capacity and skills by participating in training or taking the initiative to establish training programmes aiming at improving skills required for public engagement and transdisciplinary science (e.g., for researchers at all career stages, but also bachelor, master and PhD students).

· Provide peer support to colleagues (team science) within the same unit and explore ways to improve public engagement and utilize transdisciplinary approaches in research and education programmes.

· Be open to peer exchange with colleagues to learn from each other and help establish experience and shared networks

· To create more awareness for the value of public engagement and transdisciplinary research in terms of reaching out to citizens but also the possibility to enrich research findings through public engagement

· Make use of the currently ongoing development to enable a diversification of academic career paths, which can include a career path with a focus on impact (as facilitated by e.g., the UU's MERIT/TRIPLE model[24]).

· Make use of one's agency and power to reconfigure the university system so that it better enables open science.

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[24] https://www.uu.nl/en/news/from-merit-to-triple

University level

· To mainstream public engagement and transdisciplinary science within the general open science vision, strategy, policy, and structure, institutionalise them whenever possible.

· To open up effective spaces for learning and dialogue, starting with interdisciplinary discussions to public engagement (science communication and dissemination), citizen science and co-creation with societal stakeholders.

Maintaining the university's role as independent knowledge institutions supporting the common societal good above all political or commercial interests and helping educate researchers as critical citizens, providing them with reflective abilities and skills for public engagement and transdisciplinary research.

· An interdisciplinary approach is a prerequisite to transdisciplinarity. It is important to embed both approaches in research and education. When inter-and transdisciplinary approaches are not visible, the university should explore ways to incorporate them by facilitating dialogue and exchange and developing a growing body of knowledge or help establish a new research centre as a pioneer and embedding them in both research and educational programmes for students at all levels.

· To provide the enabling environment: financial levers, visibility, resources, capacity building and support system in both research and educational programmes.

· To establish a rewards and recognition system to support and harness intrinsic motivation of scientists to interact with the public and for their intended attempt to address societal problems through their research and education programmes. If the system is in place, develop it further to ensure that they are implementable.

· To continuously and iteratively reflect on the larger role of the university to bridge science with society, especially the marginalised and disadvantaged communities, including embedding a regular evaluation process to measure progress and updating goals.

Systemic-national level

· To improve the vision on science-society interactions, to be perceived as an essential issue at the national level.

· To diversify and scale-up funding mechanisms that adequately support public engagement and transdisciplinary research (from evaluation of proposals through to fundable costs and partnerships)

· To establish and maintain a forum to foster joint research, then reach out to scientists and inform them about these possibilities.

· To build an inventory and inform scientists about existing infrastructure, e.g.: relevant research projects or the existence of National Laboratories. Establishing a comprehensive and up-to-date information system is crucial, and direction of improvement.

· To further strengthen communication and cooperation between the actors of the innovation ecosystem (quadruple helix).

· To create a national barometer a common set of indicators to measure the impact of public policy "Science and Society". When absent, it is necessary to think about opening the national criteria for evaluating research to include public engagement and transdisciplinary science into researchers' evaluation and promotion/career advancements.

Systemic-regional level

· To embrace the autonomy and encourage universities' responsibilities to drive open science, including citizen engagement.

· To take an active role in the process of cumulation of knowledge across university alliances to enable changes on a larger, transformative scale.

· To continue developing funding mechanisms that will match wide-ranging activities to engage society in science and to address societal problems.

Specific recommendation for CHARM-EU and TORCH

· Explicitly integrate the CHARM-EU principle of inclusivity in public engagement and transdisciplinary science. Our findings show that inclusivity requires conscious efforts (and possibly extra funding) to reach out to and engage the 'unusual suspects'.

· Build on what is already there. Our findings show that there are many initiatives, structures and policies in place for transdisciplinary research and education at each of the partner universities. CHARM-EU educational and research activities should build on existing efforts and best practices and can help develop these further. In this way, we can create networks to exchange knowledge and best practices and consolidate our efforts.

· Related to the above, devise structures and models for the coordination and exchange of knowledge and best practices, including through expanding the CHARM-EU toolkit in the area of public engagement and transdisciplinarity (https://www.charm-eu.eu/toolkit).

· Build capacity of individual CHARM-EU researchers and teachers and support staff.

· Rely on both bottom-up initiatives and top-down structures in building a framework for CHARM-EU's external engagement strategy. Our findings show that bottom-up, 'loose' but highly innovative initiatives as well as top-down structures such as strategic plans come with opportunities and challenges in incentivising public engagement and transdisciplinary science. It is therefore important CHARM-EU relies on bottom-up initiatives that have the freedom to

operate, be backed up and supported by higher-level strategic plans that provide guidelines and legitimacy to these initiatives.

3.4.2 Gaps and future research agenda

The debate on open science, its role and how it could be stimulated at different levels is connected to several ongoing and lively scholarly debates, but we notice that there is room to make the connection with these debates more explicitly. First of all, the debate on open science stands in a tradition of scholarly debates within the sociology and philosophy of science. In his book 'Open science, the very idea' Prof. Frank Miedema has discussed the link between open science and mainstream sociology and philosophy of science in some detail. We notice that this is one of the rare efforts to explicitly link more abstract scholarly ideas on the role of science in society with the more practical notion of open science. Research along those lines deserves to be strengthened.

Second, and this is relevant given CHARM-EU's focus on sustainability, we notice that notions of open science and within that public engagement is more connected to some fields of research within the sustainability sciences than others. For instance, Transdisciplinarity (Pohl et al. 2008)[25] is often discussed in relation to, or as a manifestation of open science. But other lines of research from within the sustainability sciences are much less explicitly taken on board. This includes, amongst others, research on knowledge systems for sustainable development (Cash et al. 2003 in PNAS[26]) as well as various studies on knowledge co-production inspired by this work.

From our research, several gaps and opportunities for ways forward can be identified, which could serve as potential follow-up for the next phase of TORCH/CHARM-EU Alliance. The first is related to the question: How to harness open science, public engagement and transdisciplinary science as a way to involve the underprivileged in society? An exploration of how to mainstream and track the progress on achievement in promoting diversity and inclusiveness is needed. Future research to understand science legitimacy, i.e., which actor, whom, what knowledge should be included? Furthermore, the second gap identified is the lack of understanding on what would be the most effective institutional model to mainstream public engagement and transdisciplinary science within the larger open science movement? (e.g., a combination of top-down and bottom-up approaches). The complex institutional structure of European universities is a challenge, especially in terms of coordinating efforts to build on existing initiatives and to avoid reinventing the wheel. Finally, we argue that it is important to explore the contentious issues of open science as a larger movement, to realize the open science aspirations, including the issue of power asymmetry. Balancing excellence-driven research with challenges-oriented research ultimately calls for a broader definition of excellence, to overcome a mere juxtaposition of both. CHARM-EU is committed to reconciling scientific excellence with societal excellence without compromising academic freedom.

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[25] Pohl, C. (2008). From science to policy through transdisciplinary research. Environmental science & policy, 11(1), 46-53.

[26] Cash, D.W., Clark, W.C., Alcock, F., Dickson, N.M., Eckley, N., Guston, D.H., ... & Mitchell, R.B. (2003). Knowledge systems for sustainable development. PNAS, 100(14), 8086-8091.