

Towards an Inventory of Best Practices for Transdisciplinary Collaboration

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Abstract

Transdisciplinary, as opposed to inter or multidisciplinary, practices are increasing in many areas in industry, government, academia and civil society. The benefits of such practices have been proven in areas such as health, engineering, or business. However, in wide collaborations, collaboration bridges diverse fields such as art and design, humanities, science, technology, and medicine; these pose specific challenges. Institutional contexts bridge those of self-employed practitioners, to profit and nonprofit sectors both in civil society and government; training practices are less clear and specific difficulties can be anticipated. In this paper, we review some best practices and didactics for teamwork collecting relevant sources from different fields. Our conclusion is that it is possible, and necessary, to train individuals and teams for transdisciplinary collaboration practices. Depending on the field of application some approaches are shared, but also different approaches will be required. The authors recommend new research and development adapted to particular transdisciplinary fields such as STEM to STEAM.

Keywords

Best Practices, Transdisciplinary Collaboration, Art and Science

Introduction

According to Buchanan (2001), for three centuries since Renaissance, academic disciplines in much of the western world focused on incremental theory development and specialization. In the last century, researchers and practitioners from many different fields have reached a level of expertise limited to silos with difficulties to collaborate in inter and multidisciplinary challenges. In other cultures the framing of these epistemological approaches has been different and sometimes more integrative. Unfortunately, western technoculture has often not benefited from these approaches.

The rise of complex sociotechnical systems has stimulated multiple initiatives to promote inter, multi and now transdisciplinary collaboration even in traditionally opposed areas such as art and science. There is a large

literature on holistic, integrative and problem driven practices (Evans, K. 2016) The ability of individuals and institutions to integrate diverse knowledge and cultures of practice is asserted as a necessary asset, and value. We insist however that ‘integration’ does not imply ‘unification’. Transdisciplinary practices draw on and confront different research methodologies.

There is an extensive literature, going back at least a 150 years, that addresses the differences between multi, inter and transdisciplinary practices; see for instance the work of Allen Repko and Rick Szostak (2017) or Julie Klein (1991). The focus on transdisciplinary projects, particularly in the context of problem solving in societal and community projects, is a more recent development. In 1998, the United Nations Educational, Scientific and Cultural Organization (UNESCO) Division of Philosophy and Ethics published “Transdisciplinarity: Stimulating Synergies, Integrating Knowledge”. The report includes a useful bibliography which this project seeks to update.

Transdisciplinary collaboration has benefits in allowing the multiplicity of perspectives and specific methodologies. In its practice, knowledge management among different fields is motivated by the promise of collective potential. Also, participation of different professions facilitates the recognition of other knowledge and the strengthening of networks of collaborative work as well as the transfer and translation between communities. In this exploratory collection of best practices the authors reviewed selected literature from health, business, research, and design. Transdisciplinary collaborations as we discuss them are embodied by transdisciplinary practices that must draw on diverse collaboration methodologies as well as research methodologies.

There is a large and growing literature on collaboration methodologies. These include from those used, for

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instance, in business strategic alliances, where the Association of Strategic Alliance Professionals (ASAP 2017)) allows the sharing of best practices and training.

In the field of space activities, NASA for over 60 years has developed detailed methodologies. NASA's Academy of Program and Project Leadership provides ongoing improvements in management techniques for their sector. Their Collaboration on Collaboration (2017) initiative () has also inventoried specific collaboration best practices.

Initiated in translational medicine, the Science of Team Science (2016) initiative has developed specific toolkits to improve collaboration (Stokol et al. 2006).

In the military there is a very large collaboration training literature; for instance the 2017 annual ITEC conference focuses on innovation through collaboration (ITEC 2017).

In the field of design, there are several tools and methods that can support stakeholders collaboration in design projects. A major firm, IDEO, through its non-profit Ideo.org, published a website called Ideo Design Kit (Design Toolkit, 2017)) to disseminate methods of design thinking, which is both a designerly and transdisciplinary approach. Similarly, scholars at Politecnico di Milano have developed a repository of design methods (Service Design Tools, 2017).

In the transdisciplinary fields that bridge the arts and humanities to science and engineering, there is only relatively recent literature and little consolidated best practices. In 2012 Joost Heinsius and Kai Lehikoinen aggregated a number of texts for "Training Artists for Innovation: Competencies for new contexts" (Grezelec 2017). They issued a number of policy recommendations primarily focused on including artists as integral to innovation funding programs, and highlighting the specific issues of self-employed artists collaborating with professionals in institutional contexts. When such projects bridge addressing societal issues, particular challenges are encountered. Specific initiatives include those led by anthropologist James Leach (2014), those by Joline Blais and Jon Ippolito through the Cross Cultural Partnership (2017) have developed, and tested, specific cross disciplinary collaboration templates. The work, grounded in cross-cultural research across asian and european cultures, provides new insights and strategies.

Particular problems arise from very different cultures and history of collaboration; within some of the arts and

humanities, individual practice and creative authorship dominate, and collaborative practices are relatively recent. The variety of approaches of how intellectual property are addressed is complicated by the more recent moves towards open science and software movements. The 2001 Collaborative Ownership and the Digital Economy Conference (Robinson, 2001) led to the 2005 book by Rishab Ghosh with the same name (Ghosh, 2005). One of the authors of this paper (RFM), is involved in the SEAD network that published in 2015 a report, funded by the US National Science Foundation, entitled "Steps to an Ecology of Networked Knowledge and Innovation: Enabling New Forms of Collaboration among Sciences, Engineering, Arts, and Design" (Leonardo NSF e-book 2017). This report called for particular attention to improving transdisciplinary collaboration processes both between individuals and between institutions. The different disciplinary and institutional cultures pose particularly hard problems that require attention. The recent international 'STEM to STEAM' movement seeks to develop initiatives that integrate the arts/design/humanities with science/technology/medicine. In the education area, the US National Academies of Science, Engineering and Medicine have currently underway a study to address the challenges and proposed approaches (Policy and Global affairs at the national Academies 2017). In Europe, the EU STARTS initiative (ICT and Arts 2017) asserts that "the arts are gaining prominence as catalysts for an efficient conversion of science and technology knowledge into novel products, services, and processes" and funding mechanisms are in place.

Towards an Inventory of Best Practices

The panel and workshop held at ISEA2017 in Manizales was one step to continue to focus attention on these problems. Here we develop some initial areas for discussion and development.

Identify Values and Set Up the Environment for Teamwork

In projects where practitioners share an overall disciplinary culture (e.g. military, health care) in general values and success criteria are fairly easy to develop. However, in transdisciplinary projects that cross different 'ways of knowing', conflicts can arise when the individual values are not made explicit or overt. For instance, the 'truth' status of results derived from the

scientific and engineering fields may not be viewed in the same way by practitioners in the arts or humanities which emphasize individual reception within a specific cultural context. The US National Science Foundation funded Toolbox toolkit provides one approach for making implicit values explicit (Tool Box Project 2017) and in particular seeks to make clear individual participants views on the practice and values of others.

Setting personal and group goals for interdisciplinary collaborative work facilitates the recognition of the capabilities of team members and confronts participants to identify the importance of their input and the type of participation they wish to have. Likewise, it outlines the participation of the collaborators according to levels of expertise, preference for some subject or interest in strengthening certain capacities to the extent that they commit to work in a specific area.

The investment of time and effort at the initiation of transdisciplinary collaborations is significant, more significant than in inter or multidisciplinary ones. There is often resistance by individuals to develop clear understandings of differences in values and specific goals. Early discussions on intellectual property approaches can be disruptive, but must be addressed. Often in transdisciplinary collaborations there are intentionally multiple forms of outputs (e.g. discoveries for scientists, technical solutions for engineers, impactful artworks for artists, etc.) and often there are not shared criteria for success.

In health fields, there is wide study of collaboration among diverse care providers. Salas and Rosen (2013) reported the evidence about training for collaboration in this area and one of the best practice they suggested is that leadership support is the key driver of effective teamwork because organizational culture and priorities affect how staff collaborate. In less hierarchical institutions different from health, a commitment technique should be defined.

We assert that the beginning of a transdisciplinary collaboration, it is important to be convinced, through analysis, that transdisciplinary practices rather than inter or multidisciplinary ones are required.

Train Individuals to Learn Collaboration Skills.

There is an extensive research in health fields to train care providers from different specialties to work together in common goals. Salas and Rosen (2013) synthesized the progress in this research area and explained that learning

teamwork may be easy and engaging; however, practice and guided practice are the best didactics to apply knowledge in actual collaborations. They also pointed out that feedback (causes of effective or ineffective performance) help team members to improve their collaboration. In areas beyond health, collaborations may not occur with previous training programs protocols or requirements. Therefore, guided practice and feedback may need that one of the individuals is skilled and assumes the role of guide and provides feedback.

A promising training technique for collaboration applied mainly in health and aviations is the use of high fidelity simulations. But Beaubien and Baker (2004) criticized its efficacy has been because of the lack of evidence. They recommend a careful planning of the training to tailor specific needs, goals, and evaluation. In transdisciplinary collaborations, this technique would be particularly helpful when there are clear goals with determined outcomes. In more creative tasks with undetermined outcomes, simulation training may limit creativity in post-training performance.

Assign Roles to Each Individual in the Group.

Sunstein and Hastie (2014) contended that behavioral economics can explain the pitfalls of group performance because cognitive biases influence behavior of individuals in the groups. For example, people underestimate the time needed in a project (planning fallacy) or stick with endeavors that are unlikely to succeed (sunk-cost fallacy). These authors suggest that assigning roles gives member the confidence and responsibility to share information that otherwise would be hidden by the avoidance of social rejection. The advantage of transdisciplinary collaboration is that the collaborators know that others have different skillsets and worldviews. However, to enhance collaboration, roles should be clarified or constantly revised in the process. Sunstein and Hastie also suggested two similar strategies regarding role assignment. First, they recommend appointing a devil's advocate, which frees an individual from the social pressure of accepting a dominant group position. Second, they recommend establishing contrarian teams, which is a variation in which part of the group has the mission of identifying weaknesses of the decisions or outcomes.

Leading the Team from Disciplinary Diversity and Integration.

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Leadership in transdisciplinary collaboration is a task that can be performed by a participant, but it may also be desired by multiple individuals in various leadership roles. Gray (2008) suggests three approaches to types of cross-disciplinary leadership: (a) cognitive leadership to motivate participants to move beyond their disciplinary knowledges, to break schemas of thinking, and to propose expanding their limits of knowledge; (b) structural leadership that adds value to the extent that it facilitates the creation of relational bridges between participants less interaction, and

(c) procedural leadership that gives participants confidence and converts conflicts into constructive interactions. Gray recommended that leadership should be a shared process in dispersed work networks, which allows the search of the objectives of the work team to leverage from different actors.

Influence Collaborators to Exploit Their Full Potential

Another application of behavioral insights to improve teamwork is setting up rules that allow the group to overcome biases and fallacies. Sunstein and Hastie (2014) recommend three actions. First, they recommended to silence the leader, which would avoid discouraging the members to oppose authority. They made the case of underserved populations, but in transdisciplinary collaborations some disciplines could be dominant and could be “silenced” to encourage contributions of members of less dominant or non-traditional disciplines depending on the problem being tackled. Second, Sunstein and Hastie recommended priming critical thinking, which consists of specifically asking people to disclose all possible information and ideas. We believe that this action would individuals from uncommon disciplines would feel confidence to contribute. These authors also recommended rewarding group success – not individual success. This will encourage individuals to share knowledge that can potentially benefit the group performance.

Alternate Group and Individual Work to Enhance Ideation.

Perhaps the most widespread technique in the general public to generate ideas in groups is brainstorming. However, as Paulus and colleagues (2015) note, this technique has proven to reduce efficiency and efficacy of idea generation. They report exploratory studies that

point out to alternation of group and individual work to better ideation processes. This technique is known as brainwriting because whereas individuals work alone, they register their ideas before sharing them in a group.

Use the Tools and Techniques According to Possibilities of Collaboration.

The proper use of collaboration tools and techniques influence the effectiveness of teamwork and facilitate distributed asynchronous collaboration (i.e. at different times and places). Sanders and colleagues (2010), in some case studies about collaboration in design fields, noted that some tools for collaboration should be used according to the possibilities offered by the meeting, purpose of collaboration, composition and size of the group, and type of meet (face- to-face or virtual context). Likewise, Koutsabasis and colleagues (2012) identified the potential of human-based interaction technology tools by tracking multidisciplinary collaborative projects in a virtual world-type immersion environment. Their contributions highlight registration as a support for collaborative practices, the collaboration scenario and level of commitment and concentration that digital tools facilitate for distance collaboration. There is a proliferation of software tools to enable and support collaboration in general. It is unlikely that unified generally accepted tools will be developed. It is important at the initiation of transdisciplinary collaborations to make visible the use of different tools and identifying necessary integrating ones.

Structure Decision Making Based on Collective Cognition and Evidence

Decision making is one of the major challenges in teamwork. All the previous best practices can support this activity. The Delphi method is a widely known method for rational decision making incorporating both individual and group wisdom. This collective and social cognitive process is powerful to counter cognitive biases of individuals. (Sunstein & Hastie, 2014). The use of evidence for decisions also helps collaborators to focus on the benefits of the project. In codesign, evidence has shown to reduce controversy and facilitate consensus (De la Cruz & Mejía, 2017).

Heterogeneity and its Discontents

A number of studies of collaborations address both the positive and negative and challenging aspects of group

heterogeneity. Heterogeneity in this context includes aspects the mix of gender, age, abilities, ethnicity and culture, location (Cummings et al 2013). In general, for small groups (< 30) studies often indicate that more heterogeneous groups are more innovative; however, as noted by Cummings et al, as group size, locations, institutional contexts increase heterogeneity can be counter productive. The idea of ensuring heterogeneity is not to lead to a unified world view, but rather draw on multiple ways of knowing. As emphasised by the Science of Team Science toolkits referred above, it is important to understand ahead of time the impact of heterogeneity/ or lack of it, both on collaboration productivity but also on the needed training techniques.

Discussion

Transdisciplinary practices draw on collaboration methodologies as well as the diverse research methodologies within the collaboration. Collaborative work appears as a need for successful transdisciplinary efforts and communal professional activity among individuals with different expertise; collaboration is asserted as a value in itself because of its social consequences. Collaboration frames activities in a scenario of mutual benefits, where each participant contributes with her work to personal and group goals. Collaboration is expected to augment individuality because participants' peculiarities, strengths, knowledge, and skills may articulate and negotiate to achieve an integrated outcome, which could be more successful and constructive.

However, individuals have limited abilities to exploit the personal and collective benefits of collaboration. Formal or informal training methods need to be refined and tested to enhance transdisciplinary work. We are looking for multiple perspectives of training methods, because transdisciplinary work is not a homogenous culture of practice.

We are also interested in inspiration from metaphors from the natural environment. A key issue in transdisciplinary is understanding, and making explicit, the metaphors and terminology used in each discipline; we seek to clarify and make visible the metaphors and language shared in transdisciplinary practice. In nature, some animals and plants master interspecies communal living in some biological relationships and collaborative work. In mutualism, for instance, individuals from different species live together and

benefit from a relationship based on strategic alliances. There could be much to learn from the mutualism as a metaphor in human transdisciplinary collaboration, including training methods, while recognizing the limits of translating from one field of application to another.

As emphasized by a number of authors there is a need to test training methods to develop evidence of effective approaches, while recognizing the singularity of individual projects and the heterogeneity of specific project groups. Some projects are more focused on innovation as such, others on societal or cultural change. Anne Balsamo in her book *Designing Culture: The technological imagination at work* (Balsamo, 2011) emphasizes that individual innovation and transdisciplinary projects are embedded in a larger project of changing culture. Often projects are 'sub-optimal' in that the solution of a specific problem may cause unanticipated problems at the societal or cultural level. Such consequences can be studied using future casting or science fiction prototyping methods (e.g. Johnson, 2011), though the success of these techniques has not been convincingly been demonstrated.

For this project we re-emphasize that in "integrating framework" does not mean "unifying" frameworks; there is a literature on the problem of integration vs unifying approaches such as the work of Edward Slingerland and colleagues (Slingerland & Collard, 2011). A basic assertion is that transdisciplinary approaches bridge different ways of knowing and doing, and there is specific value of multiple approaches. Depending on the field of application, or problem context, some approaches are shared, but also different approaches will be required but that the results could not have been achieved with other means.

Most collaborations fail. We assert that it is necessary to develop methods and train professionals for transdisciplinary collaborations that bridge the arts and sciences.

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