Building Capacities for Transdisciplinary Research

Challenges and Recommendations for Early-Career Researchers

Transdisciplinary research is intriguing and challenging. Early-career researchers in particular, who lack experience and are still working on their disciplinary standing, struggle with difficulties and uncertainties. We offer insights into the challenges faced and solutions found by seven transdisciplinary junior research groups.

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Abstract

While transdisciplinarity offers a way to tackle complex social-ecological challenges, transdisciplinary research is a challenging task in itself. The integration of research methods across academic disciplines, the collaboration between researchers and practitioners, and the need to balance societal and disciplinary academic impacts pose many difficulties even to experienced applied scientists and even more so to early-career researchers. Young scholars face particular problems, given their lack of longer-term experience and their still fragile position within academia. Drawing on existing literature, an early-career researcher workshop, and our own experience as junior research group leaders, we discuss specific challenges and respective solution strategies of transdisciplinary research within the context of sustainability.

Keywords

capacity building, early career, social-ecological research, transdisciplinary research

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Transdisciplinarity as a mode of scientific research in support of transitions and transformations towards sustainability (Scholz 2017, Wittmayer and Schäpke 2014) is still in a phase of experimentation and has not yet become stabilized as a cross-cutting field of science (Zscheischler et al. 2017, Schäfer 2013). It can be seen as an integrative research approach that links a path of scientific innovation and a path of societal problem solution (Jahn 2008, Jahn and Keil 2006), accepts local contexts and uncertainty in knowledge generation, and generates knowledge that contributes to solving societal problems (Jahn et al. 2012, Lawrence 2010, Wittmayer and Schäpke 2014). Although interdisciplinarity is a key feature of transdisciplinary research, transdisciplinarity goes beyond interdisciplinarity by adding cooperation between science and society to the inner-scientific cooperation between different disciplines (Jahn et al. 2012, Lang et al. 2012, Pohl and Hirsch Hadorn 2008, Gibbons et al. 1994).

Transdisciplinary research is characterized by specific challenges, some of which stem from interdisciplinary collaboration (Eigenbrode et al. 2007). These include the integration of research methods across academic disciplines and dealing with differences in thought styles and in science communication (Couix and Hazard 2013). Others are of a transdisciplinary nature like the challenges of developing a common language and shared problem framing, and of balancing societal and disciplinary academic impacts (Lang et al 2012, Brandt et al. 2013). Dealing with these fundamental challenges of transdisciplinary research requires experience and the building of relevant capacities (Zucker 2012). While recent years have seen some progress (e. g., in establishing funding opportunities, strategic networks, and textbooks), the financial and strategic support for transdisciplinary research still lag behind its often claimed societal relevance. This structural uncertainty magnifies the complexity of doing transdisciplinary research, particularly for young researchers (Patterson et al. 2013). Already at the start of their transdisciplinary journey, they bear a double risk to fail either in their research task or in their scientific career or, in the worst case, in both. In the German context, so-called jun- >

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ior research groups[1] could be an effective instrument for building capacities for transdisciplinary research (Müller 2013). But does it work and what can be learnt from the German experiences? Ruppert-Winkel et al. (2015), who were members of the second cohort of young researchers funded by the program, published an ex-post self-evaluation in 2015. Based on a questionnaire and interviews with twelve research groups, they revealed that the research was characterized by a high diversity of epistemologies, thus requiring generalist knowledge from the early-career researchers who often had an interdisciplinary background. Ruppert-Winkel et al. further reported competing objectives and trade-offs between conducting good transdisciplinary research and pushing one's own career, and the constant struggle to place transdisciplinary knowledge and skills in disciplinary discourses.

While a considerable amount of recommendations for interdisciplinary career paths has been developed (e.g., National Academy of Sciences, National Academy of Engineering and Institute of Medicine 2005, Pfirman and Martin 2017, Zucker 2012), experience-based studies that reflect systematically on the specific challenges of transdisciplinary early-career researchers are still rare (an exception being Patterson et al. 2013 on transdisciplinary water governance). Against this background, the aim of this paper is to explore particular challenges of setting up a transdisciplinary junior research group, and to provide recommendations from our own experience on how to overcome those complications. As members of the third cohort of junior research groups, we relate to and build upon the approach used and findings made by Ruppert-Winkel et al. (2015), but with a much stronger focus on problems related to the initial project phase and opportunities for overcoming them. We are confident that our approach provides novel insights that are of high relevance for other – especially young-career – researchers that are confronted with emerging problems of transdisciplinary research efforts and who need to revisit and eventually redesign their project program to best address those aspects.

Methods: Analyzing German Junior Research Groups

Our research design includes a literature review, group discussions and co-operative supervision in research group leader trainings, and finally group discussions in a workshop with a wider transdisciplinary audience. The authors are currently serving as leaders of seven junior research groups funded by the German Federal Ministry of Education and Research (BMBF). Given our backgrounds in various fields, we represent an interdisciplinary constellation (see table 1 for an overview of the groups). Our paper takes a self-reflective perspective in line with our understanding of transdisciplinarity outlined above. The workshop we organized was entitled *Doing Transdisciplinary Research – Addressing Challenges Faced by Early-Career Researchers* and took place during the *International Transdisciplinary Conference 2017* on September 11, 2017, in Lüneburg (Germany). In a world café setting (see Brown and Isaacs 2005), participants identified and discussed the main challenges of early-career transdisciplinary research and formulated recommendations on how to handle them based on their own experience. To structure the workshop, we had identified, based on literature research and our discussion during the training, three overall challenges as being particularly relevant to early-career researchers: 1. interdisciplinarity and the integration of disciplinary knowledge (figure 1, p. 383), 2. collaboration between academia and society, 3. the science-policy interface[2] and science communication. In the following, we will discuss these challenges and make some recommendations based on our experience, the literature, and the results of the workshop. We will refer to the experiences in the different research groups by citing their respective group leaders.

Challenges and Recommendations

Interdisciplinarity and the Integration of Disciplinary Knowledge – How Can a Disciplinary Profile Be Established while Remaining Open to Other Disciplines?

Challenges

Since interdisciplinarity is a key feature of transdisciplinarity (Jahn et al. 2012, p. 2), challenges of interdisciplinary collaboration also become part of transdisciplinary research. The disciplinary differences in regard to research culture, discourse and presentation of research, values and worldviews are widely accepted in the literature as basic challenge of interdisciplinary collaboration (Pfirman and Martin 2017, Couix and Hazard 2013, Eigenbrode et al. 2007, MacMynowski 2007, Wuelser et al. 2012). Recommended actions include being open to other disciplines in order to transcend disciplinary boundaries (Giri 2002) or creating tools to foster mutual understanding of the disciplinary approaches and good communication among researchers of different disciplines (Pfirman and Martin 2017, Eigenbrode et al. 2007, O'Rourke and Crowley 2013, Pohl et al. 2017). Interdisciplinary cooperation, however, requires an in-depth knowledge of one's own academic discipline, with its strengths and weaknesses. Early-career researchers often struggle with gaining a comprehensive overview of their academic discipline and developing an academic identity (Haider et al. 2018, Rhoten and Parker 2004). Moreover, profound disciplinary knowledge is necessary in order to identify research questions of relevance for the respective discipline (Robinson 2008, pp. 71 f.). This is of particular importance for a doctoral thesis and for post-doctoral qualifications where researchers are supposed to contrib-

1 Junior research groups (in German: *Nachwuchsgruppen*) are a specific funding instrument for early-career researchers in Germany. Funding is provided for up to five years for a research group consisting of two to four PhD students and one or two postdoctoral researchers. This gives early-career researchers the chance to do research independently and to supervise PhD students.

2 "Science-policy interfaces are defined as social processes which encompass relations between scientists and other actors in the policy process, and which allow for exchanges, co-evolution, and joint construction of knowledge with the aim of enriching decision-making" (Van den Hove 2007, p. 807).

TABLE 1: Overview of the seven junior research groups in the funding phase 2016 to 2021.

ABBREVIATION	TITLE OF JUNIOR RESEARCH GROUP	JUNIOR RESEARCH GROUP LEADERS
–	*Digitalization and Social-Ecological Transformation – Rebound Risks and Sufficiency Opportunities of Digital Services*	Steffen Lange, Tilman Santarius
DynaMo	*Mobility-Energy Dynamics in Urban Areas*	Antonia Graf, Marco Sonnberger
MigSoKo	*Human Migration and Global Environmental Change: A Vicious Cycle?*	Kathleen Hermans
OHA	*Obsolescence as a Challenge for Sustainability – Causes and Alternatives*	Melanie Jaeger-Erben, Janis Winzer
PlanSmart	*Planning and Implementing Nature-Based Solutions*	Christian Albert, Barbara Schröter
PlastX	*Researching Plastics in the Environment from a Social-Ecological Perspective*	Johanna Kramm, Carolin Völker
RightSeeds	*Commons-Based Rights on Seeds and Seed Varieties for a Social-Ecological Transformation of Plant Cultivation*	Stefanie Sievers-Glotzbach

ute to the state of research of a specific discipline. Even though Haider et al. (2018) observed that younger generations in sustainability sciences often obtain a more interdisciplinary identity, the doctorate regulations and academic career paths suggest a disciplinary profile. Moreover, transdisciplinary early-career researchers also need to acquire at least a basic knowledge of concepts and methods in other disciplines. This is necessary in order to develop a shared "language" and manner of problem framing, and to educe joint methods (Brandt et al. 2013, p. 2, Lang et al. 2012, p. 33).

Recommendations: A Sound Research Design Is Key

The research design phase is crucial to meeting the above challenges and realizing disciplinary and interdisciplinary research simultaneously. Elaborating an individual genuine disciplinary approach and research question as well as gaining some generalist knowledge about the other disciplines and epistemologies is a prerequisite for each research design. Johanna Kramm from *PlastX* explains: "The challenge of our group is that the disciplines involved are quite diverse: ecotoxicology, chemistry, human geography, and sociology. We identified key questions on theory, methods, and concepts of each discipline, such as the significance of theories in social sciences or the reproducibility of experiments in natural sciences. The PhD students in our junior research group conducted expert interviews with researchers relevant to their discipline that helped them reflect on their educational background and identify discipline-specific characteristics, thus strengthening their academic identity." The research group members jointly discussed their results. The aims were to be able to consciously argue from one's own disciplinary perspective, to exchange problem views, to develop an understanding for other perspectives, and to work out differences. This intensive exchange created a first understanding of the different disciplinary logics, epistemological approaches, languages used, and theories involved.

A tool that was discussed during the workshop to foster a shared language was the development of an index for the terminology used, which should be understood as a living glossary. This helps to ensure that everyone understands the key terms for collaboration. At the same time, it does not imply that a common definition of all terms needs to be elaborated. In some cases this is not possible and therefore a flexible handling of the glossary is recommended.

For the integration of disciplinary knowledge a multitude of methods and tools exist, of which the identification of boundary objects has proven to be particularly productive for inter- and transdisciplinary cooperation (Klein 2008). Star and Griesemer (1989) identified several types of boundary objects, which can range from diagrams and standardized forms to specific images or topics. One definition of a boundary object is that it needs to be sufficiently flexible. This does not necessarily imply consent regarding the understanding of the boundary object, which in some cases functions rather as uniting different interests. This is a pre-requisite for the operationalization of inter- and transdisciplinary research in concrete activities, like sub-projects or organizational units with certain programs. For example, one particular tool is the interdisciplinary co-designing of research questions and methods. Kathleen Hermans from *MigSoKo* clarifies: "Our experience so far on the integration of different methods, which comprise simulation model development and qualitative empirical field research, are that they can only be successful if the respective researchers collaborate in the design phase. Our model developer has co-designed the questionnaire for the researcher working empirically in the field to make sure that the responses are useful for the model developed."

Collaboration Between Academia and Society – How Can Practitioner Involvement Be Structured?

Challenges

One important challenge regarding collaboration between academia and society is the appropriate design of practitioner involvement. The understanding and solving of complex social-ecological problems benefit from the integration of diverse perspectives. However, how can we determine the right number and set of prac- >

titioners? In order to achieve legitimacy for the research results, it is often necessary to involve a large number of practitioners (Lang et al. 2012, p. 34). Early-career researchers might tend to involve too many partners (or are prompted to do so by the calls for proposals) and later on have a hard time to juggle partners and their claims and expectations.

Moreover, transdisciplinary research is supposed to follow a co-design approach, starting with a joint formulation of the societal problem and the scientific "mission". While in an ideal form of practitioner involvement the empowerment of practice partners is generally supported by transdisciplinary researchers (Brandt et al. 2013, p. 6), this has proved to be too time-consuming for early-career researchers (Ruppert-Winkel et al. 2015). The co-design approach is also complicated when diverging interests and institutional logics become apparent. Moreover, discontinuous participation of practitioners can jeopardize the societal impact (Lang et al. 2012) as well as impair the collection of empirical data needed for academic qualification. Next to caring for continuous participation, transdisciplinary researchers have to manage the various expectations from participants and often need to assume a multitude of roles like process facilitator, change agent, and knowledge broker (Wittmayer and Schäpke 2014). Particularly early-career researchers whose scientific identity is still forming and who often have a personal interest and motive to really solve a social-ecological problem at hand (Wittmayer and Schäpke 2014) risk being swamped by expectations.

Balancing societal and academic objectives presents a further challenge. While the primary objectives of transdisciplinary research projects are the respective project goals, early-career researchers need to manage competing expectations (Ruppert-Winkel et al. 2015, p. 11, Rhoten and Parker 2004). Since they still need to work for their academic qualifications, and academic requirements are often very different from practical or societal needs, both the success of the "societal mission" and the researchers' academic career are at stake (Müller 2013). Moreover, networking opportunities with practitioners do not necessarily result in the development of synergies within academic networks. Besides, publications in the context of problem-oriented research follow different rules than publications focusing on problems of basic research. For pursuing an academic career and obtaining a PhD, publications in peer-reviewed journals are essential, while publications addressing public readers and practitioners are of less value.

Recommendations: A Flexible yet Transparent Design Is Needed

The challenges of practitioners' involvement and a co-design approach can be addressed through a flexible project design. Steffen Lange from *Digitalization and Social-Ecological Transformation* reports: "We aim to develop policies to harness the social-ecological potentials of increasing digitalization both on the corporate and the policy levels. This requires the involvement of multiple and heterogeneous sets of practitioners. Often one or several additional practitioners with specific qualifications are needed for the empirical part of the research. We found that it is almost impossible to bring all stakeholders together; therefore, we defined different modes and degrees of partner involvement." This can comprise different levels of involvement or different groups of partners (see also Stauffacher et al. 2008). Recursive processes of adding stakeholders after the problem-framing phase (Scholz et al. 2006) allow adaption to the changing needs of practitioners and researchers during the course of the project (see also McGowan et al. 2014).

Still, a flexible transdisciplinary project design should comprise expectation management, a goal agreement which can differ between groups of partners, and transparent criteria for who is to be involved and how (Scholz et al. 2006). One tool for managing project partners' expectations is, for example, the "outcome spaces framework" (Mitchell et al. 2015, 2018). Such measures help to prevent drop-outs and to avoid excessive demands being made on, and by, practice partners. In general, strong practitioner involvement is an ideal goal, but not a must if it jeopardizes the delivery requirements of academic qualification projects.

Dealing with diverging interests can be a challenge to a co-design approach, as Stefanie Sievers-Glotzbach from *RightSeeds* has found: "Our practice partners are specifically interested in the generation of transformation knowledge, such as viable communication and finance strategies for commons-based plant breeding. Our research aims mainly at system knowledge and its objective is to fill knowledge gaps regarding the ecological and social impacts of commons-based breeding and seed production on agricultural systems. We try to resolve this tension by an iterative procedural structure where we continuously integrate interim research results into the development and testing of communication and financing concepts, and feed the evaluations from the testing phase back into the scientific analyses."

Besides these practical solutions, there is a need for structural solutions that improve the framework conditions for early-career academics in transdisciplinary research. Adjusted incentives for collaboration with society, such as a funded pre-project phase for developing a shared problem framing (co-design), would enhance transdisciplinary collaboration. However, conducting such a process before the actual beginning of a project might further complicate the entire project design, posing an additional challenge. The conditions could be improved by extending the regular qualification time for early-career scholars in transdisciplinary research (and increasing their funding). In the academic realm, both working with professors who are open to transdisciplinary PhD projects and a modification of the doctoral regulations would support the successful balancing of competing project and qualification objectives.

Science-Policy Interface and Science Communication – How Can Different Logics of Transdisciplinary Science and Policy-Making Be Dealt with?

Challenges

Social-ecological research tends to be ambitious, aiming at societal transformations and major systemic reconstructions of societal relations to nature (Becker and Jahn 2006, Wittmayer and Schäpke 2014). Particularly early-career researchers in social-ecological research are often very committed to their societal goals and the

impact they want to achieve. In an ideal world, social-ecological research creates science-policy interfaces (SPIs) in order to support, inform, and influence policy-making on its path towards sustainability, an objective that – in the real world – contains great potential for frustration (Pfirman and Martin 2017). Young academics often learn the hard way that the political-administrative system follows its own rules and that political processes are much slower, and much more complex and complicated, than expected.

This issue leads to a second challenge with respect to SPIs and science communication: science and policy-making follow different logics and use different languages for framing the same issue (Robinson 2008). Even if common goals (such as the *Sustainable Development Goals*) are identified and a variety of paths and outcomes are scientifically described and envisioned, this may be thwarted by the distinct logic and timescale inherent to the political-administrative system (Parsons 2001). Where research is mostly about "finding the truth", policy-making is about finding majorities. Thus, the logics, practices, and codes of sub-systems like science, politics, and the public have to be considered (Luhmann 1977). In this regard, Melanie Jaeger-Erben from *OHA* reports: "A major challenge for us is to provide SPIs on a topic – obsolescence – which is publicly debated in a very controversial manner by seemingly unforgiving parties. The interfaces with policy-making involve strong and contradictory interference by civil society on the one hand and by stakeholders from the business sector on the other, both trying to enforce their own relevance. Moreover, the process of finding ways for a smart interlocking of competences and activities is hampered by different languages, which leads to misunderstandings about the items of cooperation, and prolongs the trust-building phase between the partners."

A third challenge regarding SPIs and science communication is the "instrumentalization trap". Transdisciplinary research is necessary and relevant for policy-making but always runs the risk of being instrumentalized – or even distorted – for political agendas.

FIGURE 1: The knowledge bases of the various disciplines need to be carefully and systematically integrated if they are to build upon each other – like the blocks in this construction.

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As Barbara Schröter from *PlanSmart* says: "In our transdisciplinary collaboration we run the risk of being co-opted by our partners. It sometimes is a struggle not to be used as a consulting agency only but to also accomplish our research ideas, and properly conduct our data collection and analysis." Due to their lack of experience and standing, early-career researchers in particular have to struggle with the danger of being instrumentalized.

Recommendations: Critical Reflection on the Science-Policy Interface Is Crucial

It is vital for young scholars to reflect on their ambitions to influence policy and on the different logics of science and politics. Therefore, transdisciplinary cooperation ought to start with an extensive and honest exchange of expectations and reflections on scopes and limitations, in order to avoid frustration on the part of early-career researchers who are strongly motivated to contribute to societal change with their research (Wittmayer and Schäpke 2014, p. 489). In this regard, Marco Sonnberger from *DynaMo* states: "Taking the vastness of the transformation challenge and the discordance of relevant actors into consideration, to me humbleness seems to be an adequate guiding principle for action. Thus, we should consider the applied parts of our research as 'pilot projects' rather than transformation endeavours, as first experimental steps towards systemic changes." Creating SPIs goes along with building relationships that need time to ripen, and early career researchers can learn a lot from a continuous reflection not only on their findings and insights, but also on their social experiences.

Early-career researchers often consider their research results as self-explanatory and a clear guide for policy making. Grasping the strategic and programmatic logic of policy-making practice, which can be stubbornly fact-resistant, will take some time. Early-career researchers need guidance to develop an understanding of the political strategies involved in building networks and majorities, and to adapt to them without starting to make politics themselves, or to change from the logic of science to the logic of politics.

Furthermore, according to our discussions, it is advantageous for junior research group leaders to gain the rank of junior professor. Some of the group leaders got this rank and some not (e. g., because they work in non-academic research institutions). The comparison of our experiences revealed that being a professor could strengthen the position when interacting with partners from practice and politics. We also recommend seeking the support and advice of mentors (particularly senior researchers and distinguished professors), which we have found to be very helpful.

BOX 1: General Recommendations for Supporting Early-Career Researchers in Transdisciplinary Research

- Providing knowledge about transdisciplinary methods in a way that is easily accessible for early-career researchers having different disciplinary backgrounds.
- Teaching soft skills (moderation, science communication, etc.).
- Enabling learning from best-practice cases.
- Bringing together early-career researchers in order to enable mutual learning from personal experiences.
- Finding mentors with experience in transdisciplinarity.

Conclusions

Our results generally reflect and further characterize the challenges of transdisciplinary research that can be found in literature, and we add our insights on how those problems can be addressed during the early phases of a project. In particular, we would like to emphasize our finding of two general dimensions of challenges. The first dimension is of a practical nature and considers the everyday scientific work of early career researchers. For example, the researchers face procedural problems that come along with, among others, the different time-lines and logics of science and (civil) society or policy-making. Another important challenge relates to the research object itself: social-ecological problems, for example, are highly complex, and it is a difficult task to find a focus that is relevant to all partners from science, politics, and society, and to create and manage appropriate interfaces around common aims and boundary objects. Furthermore, transdisciplinary researchers have to manage complex relationships and networks involving the scientific community as well as actors from communities outside of academia. Each of these communities follows its own formal and informal rules and has developed its own value system. Feeling at home in all these different communities, and being able to play by their different rules, can be very demanding for early-career researchers. They strive to meet all the above-mentioned challenges without decades of experience and without professional standing. The recommendations summarized in this paper can open up ways to successfully meet some of them. We agree with Zucker (2012) and Patterson et al. (2013) that the capacity building for early-career researchers should consist of providing both appropriate training, coaching, and mentoring, as well as arenas for interaction or institutional platforms (e. g., living labs for collaborative research and planning) that enable mutual social learning.

The second challenge dimension is of a structural nature and cannot be solved individually. These contextual challenges relate to the field of science and the preconditions of scientific work. A crucial problem is that early-career researchers in transdisciplinary research have to follow established disciplinary career paths that are generally not appropriate for the type of research they are doing, the half-scientific and half-societal problems they are tackling, and the transdisciplinary networks they establish (Patterson et al. 2013, Zucker 2012, Pfirman and Martin 2017). Transdisciplinary research findings are often difficult to be published in disciplinary journals or to be presented in respective conferences. Furthermore, transdisciplinary research questions and methodologies are not eligible for acknowledged science funds, transdisciplinary chairs and professorships are still rare, and a transdisciplinary track record is usually not sufficient when applying for disciplinary full professorships (the same also holds true for interdisciplinary career paths; see National Academy of Sciences, National Academy of Engineering and Institute of Medicine 2005,

Pfirman and Martin 2017, Zucker 2012). Facing these types of structural challenges necessitates a change of arrangements and frameworks for transdisciplinary research. As long as these changes are still ongoing, we suggest that more support should be given to transdisciplinary early-career researchers, for example in the form of an innovation fund for unusual research ideas (similar to the *Experiment Research Fund* of the Volkswagen Foundation). Such an innovation fund could provide strategic support, for example for career planning in uncertain circumstances, or for training and learning opportunities. Last but not least, a larger number of tenure track professorships for transdisciplinary researchers would decrease the uncertainties of career planning and would provide some recognition for transdisciplinary research.

All in all, some general recommendations can be derived from our findings and could be implemented quite easily (see box 1). Depending on the funding program, national context, or research community, some of them may already be in place. It should also be obvious that these recommendations cannot help to overcome all of the aforementioned challenges – the structural challenges are particularly hard to tackle – but at least some of them.

Providing advice and support for young transdisciplinary academics amounts to an investment in the further development of the field. With the experiences and ideas compiled in this paper, we hope to have played a positive role in paving the way for early-career researchers in future transdisciplinary research.

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