



Introduction

Advances in transdisciplinarity: Epistemologies, methodologies and processes



A B S T R A C T

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There has been a proliferation of contributions about transdisciplinarity during the last decade. Today transdisciplinarity is known and referenced in the natural and social sciences, and the humanities, as well as numerous professions. Hence it is appropriate to take stock of what has been achieved in both education and research during the last 10 years. These achievements include development of conceptual and analytical frameworks, a diversification of methods and approaches in precise localities, specific cases showing the creative, reflexive and transformative capacity of transdisciplinary inquiry, and concerns about the asymmetries of power and control of participants during processes of the co-production of knowledge. However, conceptual and institutional barriers for transdisciplinary inquiry are still common whereas incentives remain rare. This is not only due to the scepticism of decision makers in academic institutions, in conventional funding agencies and in policy decision making but also to the formal education and personal motives of scientific researchers in academic institutions.

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1. Introduction

In 2004, the first special issue of any ISI peer reviewed journal on transdisciplinarity was published in *Futures* (Lawrence & Després, 2004). That issue included articles from contributors who shared an optimistic perspective on the future of transdisciplinarity. Despite their recognition of many challenges, the authors envisaged a bright future for a number of reasons (Thompson Klein, 2004). At that time transdisciplinarity was a buzzword promoted by a relatively small number of academics and scientists with a western worldview.

Today transdisciplinarity is known and referenced in all regions of the world as shown by the responses to the open call for contributions to this special issue. However, the articles published herein confirm that transdisciplinarity is still not main-stream: It is rarely recognised by professional institutions; it is still rarely taught in higher education programmes, and it is not often supported by funders of research. Indeed, transdisciplinarity is considered by many to be contradictory to the basic principles of conventional scientific knowledge production (see Rosendahl et al., this issue). Consequently, it is appropriate to take stock and to revisit what has been achieved in both education and research during the last 10 years.

During the last decade, there have been numerous publications about transdisciplinarity in a wide range of peer reviewed journals, conference proceedings and books. These contributions deal with topics including architecture and urban planning, environmental issues, future studies, public health and sustainable development. It is not unfair to claim that many contributions have been descriptive accounts of transdisciplinarity applied to address concrete problems. Too many contributions during the last 10 years lack a conceptual framework. A conceptual framework can be interpreted as a way of thinking about a subject and ordering empirical evidence about it. Without this kind of framework transdisciplinary contributions will continue to be completed without cumulative knowledge production on specific topics (see Zscheischler and Rogga, this issue). In contrast, other contributions in this issue show that alternative conceptual frameworks have been developed in recent years by integrating diverse theories and concepts. These frameworks have been derived from literature reviews, observational studies and empirical research.

Beyond the ongoing debate about the lack of institutional incentives or constraints for the implementation of transdisciplinary inquiry (especially the low level of funding attributed to transdisciplinary contributions by agencies and institutions), it is appropriate to address the underlying assumptions, values and objectives commonly associated with implementing transdisciplinary contributions instead of others (see Lauto and Sengoku, this issue). Furthermore, the limitations of transdisciplinary contributions ought to be addressed (Hessels & Van Lente, 2008). These limitations include methodological challenges concerning the co-design of research programmes and projects, the co-production of information and knowledge during collaborative research, the co-implementation of interventions if and when these are agreed, the co-implementation of projects and plans, then their evaluation and the transmission of knowledge and know-how to current and future generations.

2. The contributions

The contributors to this special issue live in Australia, Austria, Belgium, Italy, Japan, Germany, Sweden, Switzerland, the United Kingdom and the United States of America. The majority of the authors are educated in disciplines of the social and political sciences as well as the humanities. However, it is encouraging that natural scientists and urban planners have also contributed. In this respect, both the geographical distribution of the authors and their disciplinary and professional backgrounds are broader than those contributors to the previous special issue in 2004.

3. Looking back to the future

Given the large number of publications about transdisciplinarity during the last decade, it is pertinent to ask what is known about their collective contribution. In this issue Julie Klein has written a succinct historical review of contributions to transdisciplinary inquiry. Her article complements her contribution to the previous special issue of *Futures* in 2004 (Thompson Klein, 2004). She notes that there has been an “exponential growth in publications, a widening array of disciplinary and professional contexts, and increased interest in science-policy bodies, funding agencies, and public and private spheres”. The analysis presented in this issue by Klein enables her to identify three recurrent discourses: First, a concern to study and act on real world challenges in a mode of inquiry commonly referred to as problem solving, which is too restrictive according to some (for example, see Mitchell et al., this issue). Second, a practice of transgression that challenges existing institutional structures and disciplinary methods of research that are not apt to deal with complex real world problems (for example, see Popa et al., this issue). Third, the practice of epistemological transcendence, or the quest for unity of knowledge by integration and synthesis using concepts of holism, systems thinking and deep structures (for example, see Defila and Di Giulio, this issue). Klein notes that underlying these three core characteristics is a growing concern about the science–society interface and innovative methods and processes for knowledge production that is relevant to societal challenges. This concern is shared by other authors who have contributed to this special issue.

4. Hidden agendas of participants in transdisciplinary processes

There is an urgent need for a new mandate for science if it is to deal more effectively with complex societal challenges (Gibbons et al., 1994; Nowotny, Scott, & Gibbons, 2001). This is the framework used by Judith Rosendahl, Matheus Zanella, Stephan Rist and Jes Weigelt to challenge the lack of attention to the hidden agendas of stakeholders during transdisciplinary research projects. The question why issues about the power and control of scientific researchers, or other potentially dominant stakeholders, have not been widely debated during the last decade should be answered. The authors challenge this omission especially given the longstanding epistemological debate about the objectivity of science. The misconception of scientific knowledge being objective and neutral still persists in society. In contrast, this article presents the reasons why asymmetries of power and control should be identified and debated: in essence the authors argue that the transformative capacity of transdisciplinary processes is at stake. Rosendahl and her co-authors suggest that the positions of all participants should be clarified in order to understand how and why they could influence the co-production of knowledge. In support of their position they refer to the feminist scientific tradition of self-reflection, specifically the debate about objectivity. They adopt standpoint theory and strong objectivity which provide the framework for a large cross-national research project about pro-poor resource governance under changing climates in six countries – Bangladesh, Bolivia, Brazil, Burkina Faso, Ecuador and India. This project was jointly conducted by the Institute for Advanced Sustainability Studies (IASS), the International Fund for Agricultural Development (IFAD) and civil society organisations in each country. The project applied a seven step process: identification of partner organisations; identification of cases; formulation of research questions and the boundaries of each case; choice of analytical frameworks; data collection; analysis of seven case studies and synthesis of results; discussion and communication of results. This international research project clearly shows that the role and responsibility of organisations and individual participants influences knowledge production processes, especially the integration of co-generated knowledge. In particular, claims about the ownership and control of these processes by project leaders (often academic researchers) can create an unbalanced position which may not be negotiable. Standpoint theory confirms that individuals have a specific social position in a group of participants that simultaneously can enable or constrain what one knows and what one can do (Harding, 2004). Hence the common claim that researchers can act as bridge builders

between science and professional practice needs careful scrutiny in specific situations, whereas too often it has been taken for granted!

5. Contributions of transdisciplinary research to sustainable land uses

It is appropriate to ask questions about advances in transdisciplinary inquiry about specific topics such as land use (Tress, Tress, & Fry, 2006). Consequently, Jana Zscheischler and Sebastian Rogga present the results of a meta-analysis of a review of 299 articles obtained by a structured literature search of transdisciplinary contributions in the field of land use science. The aim of their article is to analyse the relations between theoretical advances and research processes, and to assess the extent to which transdisciplinary research actually contributes to sustainable land uses. The authors note an exponential increase in publications during the last decade. They also found an increasing conceptual consistency between the large numbers of theoretical discussions about transdisciplinary research in this field during the last 10 years. However, despite these advances, they state that knowledge integration is still rarely conceptualised or investigated with respect to real world situations. In addition, the roles and responsibilities of non-scientific participants in transdisciplinary inquiry is still not endorsed as a subject of study in its own right. Finally, Zscheischler and Rogga note a lack of self-criticism, notably too few reports about setbacks, or failing to achieve outcomes. In conclusion, they state that the achievements of transdisciplinary research in dealing with real world problems about land uses are quite limited. This conclusion questions the underlying assumptions about the added value of transdisciplinary contributions.

6. Reflexivity in transdisciplinary research on sustainability

Transdisciplinarity has been distinguished from action research by its ingredient known as reflexivity (Alvesson & Sköldberg, 2009). In their article “A pragmatist approach to transdisciplinarity in sustainability research: from complex systems theory to reflexive science”, Florin Popa, Mathieu Guillermin and Tom Dedeurwaerdere argue that too little concern has been given to the fundamental role that reflexivity assumes in transdisciplinary research about sustainability even though multiple groups of stakeholders and scientists have been involved. It is not unfair to claim that the normative assumptions and values used to define and delimit problems and then analyse them have rarely been explicitly addressed. This concern about the shortcomings of research on sustainability is shared by a large number of social scientists who challenge the assumption that sustainability is value neutral. In this article, the authors propose a methodology that combines conventional consensus building processes with a more open-ended action oriented transformative approach to address and solve concrete problems within the framework of sustainable development. The authors propose four main characteristics of reflexivity: collaborative deliberation to develop a shared understanding of a problem; the social relevance of the problem framing; social experimentation and collective learning processes; and the critical and transformative character of the research agenda. The authors apply these descriptive, analytical and transformative characteristics to present a typology of approaches that can be used to assess the role of reflexivity in transdisciplinary research. They also distinguish between the epistemic and social roles of stakeholder involvement to propose four distinct kinds of contribution: a complex systems approach; a technocratic transition management approach; an approach with an extended peer community; and a critical-transformational approach. Each of these approaches to transdisciplinarity is illustrated by recent research contributions.

7. Showcases of transdisciplinarity

The next five articles present conceptual and methodological issues concerning collaborative initiatives with participants having a range of backgrounds and positions: What is the purpose of transdisciplinary contributions? Who should participate? What methods can be used? The following contributions confirm that transdisciplinary inquiry about sustainable development in precise situations requires innovative research methods. Transdisciplinary inquiry challenges those researchers who work isolated in ‘ivory towers’ and professional experts who are disconnected from civil society.

8. Collaborative processes for knowledge production

In their contribution to this issue Elisabeth Schuppenlehner and Marianne Penker discuss core issues about the definition and the implementation of group processes. They consider these issues are crucial to the effectiveness of transdisciplinary contributions if they are to be considered as creative social processes of knowledge production. The authors note that the management of group processes is a recognised challenge and that these processes influence the outcomes of transdisciplinary research. The authors clarify what constitutes a group, group development and social learning processes. Then they apply the concept of Theme-Centred-Interaction (TCI) proposed by Ruth Cohn, a Swiss psychoanalyst and psychologist. They briefly explain the four components of TCI – each individual with specific interests and needs (I); the interaction and relations between the participants (We); the theme or purpose of concern (It); and the framework, environment, conditions and circumstances in which collaboration occurs (Globe). Then they argue that these four components need to be addressed simultaneously if participatory collaboration is to become a social learning process for the participants. This framework is then used for collaborative processes leading to the definition of four scenarios for the city of

Korneuburg, near Vienna, Austria until 2036. The authors synthesise their theoretical analysis and the empirical evidence of this case of urban futures by five propositions concerning the limitations and the contextual conditions for participatory processes during transdisciplinary inquiry. These propositions merit debate in the immediate future.

9. Transforming science: collective and transformative learning processes

In their article “Rethinking Science for Sustainable Development: Reflexive Interaction for a paradigm transformation” Andreas Kläy, Anne Zimmermann and Flurina Schneider request a critical rethinking of the role of science in processes of knowledge production for the definition and implementation of sustainable development. Like [Brown and Lambert \(2013\)](#), they propose a paradigm transformation concerning the conception and institutional setting of scientific knowledge production. The authors stress that sustainable development is normative and explicitly concerns values. Their paper is grounded in a critical review of the contradictory claims of science policy, and sustainable development policy. Furthermore, the authors contest the claim that science is objective, and they criticise the inability of scientific contributions to shift the definition of public policies and collective behaviour towards sustainable development goals in the global North. Kläy, Zimmermann and Schneider propose a transformation of scientific inquiry based on the theoretical and applied learning approach known as ‘Theme-Centred-Interaction’ proposed by Ruth Cohn. They recognise that people trained in different disciplines need to develop a common language based on a shared concern for sustainable development. In addition they postulate that the thought collective that can emerge from a shared learning process should create a strategic niche beyond the boundaries of any single discipline, within which each participant can become an agent of change in his/her discipline. This is the framework in which transformative science can contribute to the challenges of sustainable development. This contribution is grounded in over 30 years of theoretical and methodological research about national development programmes in diverse cultural contexts in Europe and the South.

10. Rethinking the outcomes of sustainability research

Transdisciplinarity should be concerned with more than the constituents or phases of research processes ([Lawrence, 2010](#)). It should encompass the institutional framework for the funding, organisation and dissemination of the outputs of transdisciplinary contributions especially when these are meant to address issues about sustainability. In this context, Cynthia Mitchell, Dana Cordell and Dena Fam challenge the majority of publications about transdisciplinary research which focus strongly on the content and process of inquiry rather than the outcomes and added value of this type of research. This article presents a novel conceptual framework that can enable the conception, formulation, implementation and assessment of purposive transdisciplinary research projects. The authors state that defining desired outcomes at the outset (in contrast to problem solving) will have significant implications for how transdisciplinary research is conceived, designed, implemented and evaluated. They also acknowledge the normative nature of intentionally creating change to promote sustainability and then define the desired deliverables using the concept of ‘outcome spaces’. Then three ‘outcome spaces’ are presented. These are the situation or issue of concern and its envisaged improvement or change; the stocks and flows of different types of knowledge held by and exchanged between institutions, individuals and societal groups; and mutual and transformative learning processes for the participants which shift their capacity to act differently in the future. This proposal is similar to others, including Miller et al., who requested a shift from the analysis of problems to “interrogate the social, political and technological dimensions of linking knowledge and action” ([Miller et al., 2014](#)). This approach to mutual and transformative learning processes by researchers and participants also aligns with the concept of a learning collective proposed by Ruth Cohn and endorsed by the authors of the two preceding articles in this special issue.

11. Overcoming barriers to innovative methodologies

“One Human Settlement: A transdisciplinary approach to climate change adaptation research” has been co-authored by Silvia Serrao-Neumann, Gemma Schuch, Ben Harman, Florence Crick, Marcello Sano, Oz Sahin, Rudi Van Staden, Scott Baum and Darryl Low Choy. The authors consider how communities can be proactive rather than reactive in relation to the impacts of global climate change at the local level. This is challenging because climate change is still abstract and distant for many people. The capacity of communities to adapt will be influenced by their joint understanding of the threat; a consensus about the need to deal with it; the co-production of interventions to reduce the threat; and the integration and application of different kinds of knowledge. This article shows a way forward in response to these societal challenges. The authors present their research consortium known as the South East Queensland Climate Adaptation Research Initiative (SEQCAR). The persons involved represented diverse scientific disciplines and academic departments, public authorities at different geo-political levels (local and regional), the private sector and local communities. This experience confirms that theme-based collaborative initiatives with non-academic participants having a range of backgrounds and positions require new research methods. The authors confirm that scenarios are useful tools to enable contributions of multiple disciplines and professions because they enable dialogue and consensus building ([Schwartz, 1996](#)). Then they discuss the challenges that should be confronted during the development of options in the realm of public policy, professional practice and participatory research methods. These vary according to cognitive, normative and structural barriers and extend to institutional barriers that hinder collaboration both inside and outside the public and private sectors. Consequently, these conventional boundaries

should be contested and, where necessary, they can be overcome in order to reconsider the interrelations between the impacts of climate change and health effects on local communities.

12. Co-producing knowledge for urban planning

Ten years ago the special issue contained a set of articles concerning architecture and urban planning. In this issue the article by Merritt Polk presents on-going transdisciplinary programme by a consortium of university based researchers and non-academic partners (professional practitioners in the public and private sectors) who collaborate in the Mistra Urban Futures programme in Gothenburg, Sweden since 2010. This partnership is similar to a “community of practice” (Wenger, 1998). The programme is led by the academic researchers, as is so often the case in transdisciplinary initiatives. Implementing the co-production of knowledge presented in this article refers to processes of joint knowledge creation using five kinds of contribution (including inclusion, collaboration, integration, reflexivity and usability) which are applied to analyse multi-level decision making processes, adaptation to climate change, empowerment of disenfranchised citizens, initiatives for sustainable urban development led by the private sector, and communication and visualisation tool for education and planning. The co-production of knowledge about each of these subjects is delimited and prescribed by a specific societal context as well as the dialogue between academics and non-academic participants. The Mistra Urban Futures programme is similar but not restricted to action research, interactive social science, team science and participatory research. The applications of transdisciplinary inquiry in Gothenburg are broader in scope, and they are supported by generous funding that enables longer term commitment than individual projects. This is crucial in order to tackle the organisational and institutional barriers encountered during the first 2 years of this programme.

13. Implementing methods of synthesis

It is generally recognised that the integration of different types of knowledge and know-how is a core ingredient of transdisciplinary research (Bammer, 2005). The contribution by Rico Defila and Antonietta Di Giulio in this issue is derived from their position that there has been too little concern about the epistemological and methodological challenges that need to be addressed in order to achieve the integration of different types of knowledge during interdisciplinary and transdisciplinary research projects. The authors' position is founded on a comprehensive review which identified a chasm between one set of contributions that is primarily theoretical and a second set that is mainly concerned with addressing practical needs. They stress that designing, implementing and moderating integration processes during a project is an ambitious, creative and complex task that is crucial to the outcomes of both interdisciplinary and transdisciplinary research projects. They note that integration should be grounded on consensus building and that the epistemic management of research processes is crucial in order to achieve what they term ‘a common result’. In order to achieve this goal the authors propose an ‘Inventory of Synthesis’: this is an instrument that enables the description and structuring of the outcome of a specific research project in order to identify a consensus between the participants about where the methods of integration are necessary during the research process. According to the authors, the way in which integration methods are combined and sequenced during a research project are crucial to its scientific validity and outcomes.

14. Incentives and barriers to transdisciplinarity: perceptions of researchers

The next three articles in this issue address conceptual and methodological barriers for the conduct of transdisciplinary research in Japan, the United Kingdom and Switzerland. The first article titled “Perceived incentives to transdisciplinarity in a Japanese university research centre” is by Giancarlo Lauto and Shintaro Sengoku. They present the results of an empirical study of the drivers and incentives for both senior and junior researchers working in life and material sciences to conduct and prioritise transdisciplinary inquiry in contrast to conventional disciplinary research. The authors note that the three main characteristics of transdisciplinary research in their field are a concern with societal problems, integration across the disciplinary boundaries of cell biology, chemistry and physics, and involvement of stakeholders. The authors study their research question using the institutional framework of the coordination of scientific communities, and the interrelations between external incentives and individual preferences for the definition of personal research strategies. They apply the conceptual framework of psychological economics to the definition and management of academic research initiatives derived from principal agent theory. In essence this framework provides the foundation for a quantitative and qualitative study of the perceived benefits that one hundred scientists reported about their motives for conducting either disciplinary or transdisciplinary research. The empirical results confirm that although transdisciplinary research is highly ranked by all scientists only a minority gives it priority while participating in both conventional disciplinary and transdisciplinary research. The authors conclude that there are important institutional barriers that create conflicts between personal motives and external criteria. The authors stress the need to define and apply research evaluation systems and career paths that are consistent with the aim of transdisciplinary inquiry in order to strengthen the science policy interface concerning major societal challenges.

In the second article, Catherine Lyall, Laura Meagre and Ann Bruce review those contributions across all domains of research in the United Kingdom since 2004 that adopt principles of transdisciplinary inquiry. They note that the term transdisciplinarity has not been widely used during the last decade even though research funding has increasingly targeted

societal issues and the relevance of applied research to address them. They highlight the perceived lack of a shared conceptual framework for transdisciplinary research in the United Kingdom which they consider as an important obstacle for increased funding and thus greater implementation of these kinds of contributions. The analysis of five case studies leads the authors to conclude that although transdisciplinarity has not been commonly referenced many of its underlying principles are applied in processes commonly referred to as knowledge exchange and the co-production of research. These kinds of contributions have been financially supported by national research funding policy. This support is related to a growing concern about the economic (financial) impact and societal relevance of academic research, especially in relation to knowledge about real world issues such as public health and innovative technologies. The subjects addressed by the authors in this article raise generic questions about the impact of scientific research (whether multi-, inter- or trans-disciplinary in kind) on policy definition and implementation. For example: does the participation of stakeholders in transdisciplinary inquiry confer legitimacy to those decisions taken by policy makers even when these decisions have not integrated fully the point of view of stakeholders?

In the third article, Frédéric Darbellay poses the question whether institutional, epistemological or methodological obstacles hinder the implementation of transdisciplinary contributions in Switzerland even though their number has increased significantly during the last decade. He also considers whether these recent contributions implement a 'new thought style' that requests the reorganisation of conventional disciplinary structures based on the recognition of transdisciplinary research as a kind of research in its own right that specifically addressing societal issues. Darbellay refers to a qualitative research project that analyses inter- and trans-disciplinary research in several Swiss universities. This recent study included an on-line survey of 65 researchers who conduct interdisciplinary research with the support of their universities. This survey was complemented by in-depth interviews with some respondents. The findings of this empirical study are worthy of comment. First, although there is no general consensus about the meanings and uses of terminology (e.g. multi-, pluri-, inter- and trans-disciplinarity) the study also found that conceptual interpretations are not discussed, negotiated or-co-defined during interpersonal communication between participants of research groups. According to Darbellay, this lack of dialogue and consensus building (which this author has also found in Switzerland and other countries) is a significant obstacle to the implementation of inter- and trans-disciplinary contributions. The fact that researchers in Swiss and other universities can adhere to interdisciplinary or transdisciplinarity without debating what these terms mean in the context of specific projects is disconcerting to say the least! Second, this obstacle is nurtured by the disciplinary organisation of research, the production of scientific knowledge and its integration across conventional disciplinary boundaries. Third, the idea of 'thought style', originally proposed by Ludwik Fleck, is reapplied in this article to show that different thought styles coexist in transdisciplinary inquiry. This is precisely why inter- and trans-disciplinary research should be founded on negotiation and consensus building processes which is clearly not the case reported in this article. However, the challenges of dealing with scientific and non-scientific thought styles must be addressed by the participants in transdisciplinary inquiry before they transgress conventional disciplinary boundaries in order to collaborate.

15. Pedagogy in the classroom: learning by doing

The next two articles present examples of innovative teaching in an Australian and a Swiss graduate teaching course. These contributions show how teaching and research can be combined and co-ordinated to reinforce each other. These two examples are encouraging given the need to understand the interpersonal relations during transdisciplinary research processes. In particular, the capacity of students to understand and interact with others from a number of different disciplines and professions will enable the co-production of knowledge.

The first article "Prompting transdisciplinary research: promising futures for using the performance metaphor in research" is written by Davina Boyd, Marleen Buizer, Renato Schibeci and Catherine Baudains. Their contribution presents a heuristic that aims to encourage researchers to think about their contribution as if it were a performance, and then imagine different performances with the aim of encouraging creativity and reflexivity. In this sense, they have formulated, applied and assessed a rapid, exploratory process that enables the persons involved to discover the dilemmas and potentials of transdisciplinary research. The authors argue that innovative contributions and creative research methods are needed if transdisciplinary inquiry is to overcome well known conceptual, institutional and social barriers that impede the implementation of inter- and trans- disciplinary research. The theoretical framework presented by the authors is borrowed from the seminal contribution of the well-known sociologist Irving Goffman, who used the metaphor of a theatre performance to characterise the daily face-to-face behaviour of people in specified places or settings. The novel position of the authors is that transdisciplinary research requires a specific kind of social interaction between the participants which is unique and different from conventional roles and responsibilities in disciplinary research. The authors completed ten interviews with researchers in the field of environmental studies to formulate rich descriptions of research as practice. Then the performance metaphor was tested with 37 graduate students having different disciplinary backgrounds. The workshop with graduate students shows that when research is interpreted as performance then the students mention an increase in their creativity and reflexive thinking. In addition, this contribution questions common expressions such as "knowledge transfer", which assumes that researchers are "holders" of knowledge and the public are the "receivers" of it independently of plausible interpersonal relations between these different groups which can evolve over time. The authors note that the capacity of an individual to transgress disciplinary or professional boundaries and "think out of the box" is a fundamental characteristic of transdisciplinary inquiry that has rarely been promoted by formal education and training.

In the second article Jörg Balsiger regrets a lack of shared concern about the role of education in mainstream contributions about transdisciplinarity during the last decade. This deficit can be contrasted with the seminal OECD conference in 1970 on inter- and trans-disciplinary contributions to both teaching and research. Balsiger's article has two main parts: The first provides a conceptual framework for classifying different types of transdisciplinarity. Balsiger argues that the conceptual distinction between different types of transdisciplinarity is pertinent because it can indicate that some kinds of contributions are more appropriate than others in specific situations. His proposed typology applies well known categories, namely collaboration/participation, evolving methodologies and integration. This typology can be applied during the analysis of specific transdisciplinary issues in the classroom. The second part of the article presents a teaching exercise completed by students enrolled in a Master Degree course on sustainable development at the Swiss Federal Institute of Technology in Zurich. The exercise is an example of collaborative thinking between students that have undergraduate degrees in different disciplines. The feedback from the students about this exercise during three academic years (2008–2010) has been important in endorsing the effectiveness of simulations and role playing for teaching transdisciplinary inquiry. The evaluative process also enables Balsiger to show the pertinence of his proposed typology as well as directions for the development of this pedagogical approach in the future.

16. Quality assurance: an ongoing debate

Thomas Jahn and Florian Keil have titled their article "An actor-specific guideline for quality assurance of transdisciplinary research". Their contribution is meant to respond to the lack of systematic concern about a generally accepted quality standard of transdisciplinary research, which they claim has restricted a greater number of this kind of contribution. Given the scepticism expressed by many about transdisciplinary research during the last decade, it is noteworthy that the authors state that the quality requirements for disciplinary research should play a role in ensuring the quality of transdisciplinary contributions. However, they emphasise that alone these requirements are not sufficient because they do not address the constituents of research processes involving stakeholders. Therefore, Jahn and Keil propose a checklist of criteria that can be applied as a guideline for the quality assurance of contributions both in terms of the quality of disciplinary research as well as effective responses to policy related issues about societal challenges concerning sustainable development. These criteria are derived from nine quality dimensions or characteristics of the research problem, the research process and the research results. It is notable that the checklists of criteria are addressed not only to researchers, but also programme managers and research funders, as well as policy decision makers. Thus, in contrast to some recent publications that propose to evaluate transdisciplinary research using normative standards, the authors propose an alternative tool that can assist the three distinct groups of users to promote transdisciplinary contributions.

17. Beyond transdisciplinarity

In her article for this issue Valerie Brown reviews many contributions about the collective construction of knowledge. She discusses some research projects about the collective mind and then presents prototypes formulated by some key thinkers. Brown challenges the capacity of many transdisciplinary contributions to deal with global challenges in a creative and transformative way. In the context of research about sustainable and unsustainable futures, she argues that transdisciplinary inquiry should benefit from the capacity of the human mind to think creatively about alternative futures. She explains how this way of thinking transgresses the boundaries of scientific responses to complex societal questions. This transformative thinking embraces social, physical, ethical, aesthetic, empathetic and reflexive questions that deal with plausible futures. Today, many authors argue that a positive future for human life and sustenance on Earth is difficult to imagine with respect to recent and ongoing, ecological, economic, political and other societal trends. Brown contests this kind of narrow minded thinking. She proposes a positive approach founded on the imagination of the collective human mind, which has been endorsed by many seminal authors. She notes that the capacity of individuals to work together to create a higher level of shared understanding has been illustrated by many sustainability initiatives at the local community level in Australia since the early 1990s. Hence Brown notes an encouraging trend away from conventional knowledge production processes to initiatives that apply a broader interpretation of human thinking about alternative futures.

18. Synthesis

The 18 articles in this special issue do not claim to be representative of the numerous contributions about transdisciplinarity during the last decade. In particular, it is noteworthy that although there is a relatively large number of contributions concerning public health during the last 10 years there is no article about public health in this issue despite omnipresent challenges of communicable diseases (e.g. ebola) and non-communicable diseases (e.g. cancers and cardiovascular illness) (Kirst, Schaefer-McDaniel, Hwang, & O'Campo, 2011).

Even more disconcerting is the fact that all the articles in this issue have a leading author working in an academic institution for higher education or research. Hopefully researchers working in privately funded institutions or non-government organisations will contribute to publications of this kind in the future. The specific contribution that they could

provide concerning the interpersonal relations between academic and non-academic participants during the co-design of research programmes and projects, and the co-production of information and knowledge, and the co-implementation of outcomes should enlarge current understanding of transdisciplinary inquiry in the future.

There have been methodological advances during the last decade which are clearly illustrated by several contributions in this issue. Although there is still a strong focus on problems, problem framing and problem solving, there clearly is a growing number of authors who challenge interpretations of transdisciplinary research that do not address broader social and political dimensions that ought to be integrated into the research agenda. The tripartite sequence of problem framing, problem analysis and implementation, which has commonly been applied during the last decade, has been enlarged and applied by several authors in this issue; for example, Schauppenlehner and Penker propose a seven step process which precedes and follows this tripartite sequence. This kind of methodological development stems from numerous research programmes and projects that have been implemented to deal with the challenges of sustainable development, land use planning, urban development, or adaptation to climate change in precise localities.

During the last decade there has been a debate about the accountability and credibility of science with respect to uses of empirical knowledge to formulate political agendas about societal challenges (the case of data and information about climate change is a prime example). This debate has raised issues about the influence of ideology and political movements on the conduct and outcomes of scientific research. In this context, transdisciplinary contributions have been challenged with respect to their scientific quality and their capacity to influence change. Several contributions in this special issue address these issues. They confirm that transdisciplinary inquiry can increase the relevance of research processes and the acceptability of the results to stakeholders in civil society. However, transdisciplinary contributions cannot guarantee institutional or political support for the results of these processes. Hopefully, the diverse contributions in this issue will assist readers in recognising the political sensitivity of research and teaching initiatives. The papers included here not only question the role and function of elected officials who are meant to serve the public good, but also the scope and limits of disciplinary expertise.

Collectively, the articles in this issue underline important cultural differences between Australian, British and North American contributions about transdisciplinarity during the last decade. These differences stem from diverse interpretations of the word transdisciplinarity in the English speaking world. These differences are increased when French speaking, German speaking or other linguistic cultures are compared. Rather than a barrier to the advancement of conceptual frameworks, the cultural diversity of contributions can be enriching, provided that transdisciplinary inquiry within and across linguistic borders is grounded in concerted communication that develops a mutual understanding of the situation being considered. Further advances with respect to the cultural diversity of transdisciplinary contributions are warranted in the future.

19. Conclusion

It has not been a simple task to publish this special issue following the significant number of responses to the open call for contributions late in 2013. However, as Guest Editor of this issue I am grateful to many and express my sincere thanks to all those who have actively assisted this publication. In particular, all those who submitted abstracts in response to the call; each of the authors who contributed draft papers that have been assessed by a peer review process; the numerous persons who kindly read and evaluated one or more papers; and last but not least, Professor Ted Fuller, Editor-in-Chief, and the production staff who have fully supported this project and its publication. This is witness to an international co-production process that will hopefully serve advances in transdisciplinary inquiry in the future.

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