



What is progress in transdisciplinary research?

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ABSTRACT

In disciplinary research progress is reached and assessed by referring to the state of research in a specific field. But what is progress in transdisciplinary research, where several disciplines and further societal actors may be involved? Based on the conception of transdisciplinary research as a collaboration of academic as well as non-academic thought-styles, and based on the understanding of transdisciplinary research as research that develops a comprehensive, multi-perspective, common-good oriented and useful approach to a socially relevant issue, the question of progress is discussed for four viewpoints: (a) the people concerned about the issue are much less interested in the question of progress in transdisciplinary research than in a better handling of the real world problem; (b) members of a disciplinary, business, governmental or civil society's thought-style, who gain a more comprehensive understanding of an issue through the transdisciplinary research process, are more interested in further elaborating the issue within their thought-style, than in general lessons on progress; (c) progress on the level of personal experience mainly means that members of academic or non-academic thought-styles realize that they are a member of a specific thought-style among others. Progress would be made by integrating this experience in general education and special training; (d) finally a lot of general lessons can be learned and elaborated as tools, cases studies and approaches from the perspective of a thought-style interested in how to understand and manage transdisciplinary research.

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1. Introduction

The future of knowledge production will see more inter- and transdisciplinarity. This is certainly true, for example, for physicists, biochemists and medical scientists collaborating in the interdisciplinary field of nanotechnologies. This is hopefully true for the collaboration of natural, social and medical sciences, humanities and engineering as well as further stakeholders to address socially relevant issues in a comprehensive and non-reductionist way. It is the latter way of knowledge production that will be discussed subsequently.

In disciplinary research the question of whether a contribution is seen as progress is answered by referring to a specific state of research. This state of research also has to be indicated when writing a proposal for research funding. The state of research does not only include current factual knowledge, but also what is seen as relevant open questions and as reliable methods, concepts and theories [1]. But what is the point of reference – the state of research in the field – in transdisciplinary research where different academic and non-academic actors are involved.

Some years ago I carried out research at an institution dedicated to the dialogue between the sciences. “Sciences” here stands for the German “*Wissenschaften*” and comprises natural, social and medical sciences as well as humanities and

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engineering. I remember stimulating and frustrating discussions in a project team made up of a philosopher, a sociologist, an anthropologist and an environmental scientist. In relation to progress, I had two different feelings: On the one hand, I gained a number of new insights on the issue we discussed—the implicit assumptions of scientific experts on lay people. On the other hand, I experienced several situations of *déjà vu*, particularly when trying to integrate our thoughts originating from different disciplinary backgrounds, and making no progress in the question of how to integrate. According to Gibbons et al. [2], however, researchers can become experienced and competent in how to co-produce knowledge:

“Characteristically, Mode 2 research groups are less firmly institutionalised; people come together in temporary work teams and networks, which dissolve when a problem is solved or redefined. Members may then reassemble in different groups involving different people, often in different loci, around different problems. The experiences gathered in this process create a competence which becomes highly valued and which is transferred to new contexts.” [2, p. 6].

But what does this experience and competence imply? Could it be elaborated as explicit knowledge? And could such explicit knowledge help projects to be better than their forerunners, thus leading to progress in transdisciplinary research?

In the following, progress of transdisciplinary research will be addressed in four steps. The first section will outline the understanding of transdisciplinary research taken as a basis. This understanding will be positioned within the current debate on transdisciplinarity. The second section will introduce the concept of thought-styles. The thought-styles will be used in the third section to describe the interaction of perspectives during a transdisciplinary research process. Based on the interacting thought-styles and the understanding of transdisciplinary research, four kinds of progress will be distinguished and discussed in section four, followed by the conclusion.

2. Positioning transdisciplinary research¹

“Universities have departments, the real world has problems” [4, p. 29]. This short saying is a straightforward way to describe what transdisciplinarity is about: the concern that knowledge production in the academic sector evolves along disciplinary requirements, and thus in a different structure, than what would help to address societal issues in the real world. Even if what transdisciplinarity is about can be captured in such a short phrase, Carew and Wickson [5] are more wishful than descriptive in stating: “the emerging community of [transdisciplinary] scholars appears to have reached broad consensus on the characteristics of [transdisciplinary] research”. The meaning of transdisciplinarity is still contested. Whoever doubts this might look up the term on Wikipedia. In February 2011 the first thing (s)he reads is a message warning that the neutrality of the article on transdisciplinarity is disputed, that it may contain original research or unverifiable claims and that the article may require a general clean-up to meet Wikipedia’s quality standards. This is not a recent warning, but one that has been posted for several years.

In other respects Carew and Wickson [5] are right: The fact that the meaning of transdisciplinarity is contested does not imply that anything goes. A recent analysis of definitions of transdisciplinarity revealed two recurrent patterns [6, pp. 69–88]. The first is, that definitions of transdisciplinarity usually propose a progression from multidisciplinary through interdisciplinary to transdisciplinarity. It is a progression because every “x-disciplinarity” goes further than the previous one in a specific respect. According to Jantsch the progression is the degree of coordination within the whole education and innovation system [7]. Rosenfield on the other hand sees the progression in the development of a shared conceptual framework [8, p. 1351]. For Lawrence finally the progression lies in the bodies of knowledge and societal groups involved [9, pp. 488–489]. Thus, while the definitions share the common pattern of progression from multi-, over inter- to transdisciplinarity, the understanding of what constitutes the progress differs.

The second common pattern is the limited number of features used to characterize transdisciplinarity—Carew and Wickson’s “broad consensus on the characteristics” [5]. These features are (1) the focus on socially relevant issues, (2) transcending and integrating disciplinary paradigms, (3) doing participatory research and (4) the search for a unity of knowledge beyond disciplines. Definitions of transdisciplinarity can be classified into three groups according to how they weigh these four features (see Table 1).

According to concept A, transdisciplinarity is research that transcends and integrates disciplinary paradigms in order to address socially (as opposed to academically) relevant issues. The rationale for transcending and integrating disciplinary paradigms is that academic knowledge, organized from a disciplinary perspective, has to be re-organized and re-assessed in order to be relevant for addressing socially relevant issues. Representatives of concept A are to my understanding Rosenfield [8], Jantsch [7] and Mittelstraß [10,11].

Concept B of transdisciplinarity starts from concept A and adds the inclusion of non-academic actors (i.e., doing participatory research) as a feature. The inclusion of the non-academic actors takes up the discussion on Mode 2 knowledge production, which was influential in Europe over the past decade [2,12]. Mode 2 knowledge production takes place in the context of application and includes knowledge- and stakeholders from science, civil society, the private and the public sector. Representatives of concept B are Kötter and Balsiger [13], Scholz [14,15] and Lawrence [16]. As Möbjörk points out, doing participatory research does not yet define the intensity of the involvement of stakeholders. Concept B can thus be further

¹ For an extended version of that section see [3].

Table 1

Three concepts of transdisciplinarity (A–C) as combinations of four features [3, p. 76].

Transdisciplinarity according to concept	A	B	C
Features of transdisciplinarity			
Relating to socially relevant issues			
Transcending and integrating disciplinary paradigms			
Participatory research			
Searching for a unity of knowledge			

clustered according to whether the transdisciplinary approach aims at consulting societal stakeholders, or at making them participate from problem framing over problem analysis to bringing results to fruition [17].

Concept C of transdisciplinarity adds the search for a unity of knowledge to concept A. The overall aim is – like with concept A – to reorganize the academic knowledge in order to make it useful for addressing socially relevant issues. The knowledge is reorganized by developing the basis for a general viewpoint or perspective beyond all disciplines. Once such a fundamental structure of knowledge beyond all disciplines is revealed, the socially relevant issues can be structured, analyzed and processed from that viewpoint. To my understanding Nicolescu [18] and Ramadier [19] are representatives of concept C of transdisciplinarity.

Hence, even if there is a consensus about the main features of transdisciplinarity, there is still dissent on which of the four features is the one that distinguishes mere inter- from real transdisciplinarity (Table 1). This dispute among the positions and their defenders is what prevents the Wikipedia entry on transdisciplinarity from coming to a closure.

Table 1 is helpful for discussing different concepts of transdisciplinarity. It is an “approachology” juxtaposing alternative framings of transdisciplinarity. Klein [20] proposes a more elaborated grouping of “the diversity of activities associated with [transdisciplinarity]”. Reviewing the meanings, terms and conceptual distinctions associated with inter- and transdisciplinarity over the last 40 years, she identifies five conceptual clusters of definitions. Not reflecting Klein’s rich description, the simplified clusters are: #1 specialization – integration; #2 unity of knowledge – complexity; #3 isolation – participation; #4 reliable knowledge – socially robust knowledge; #5 mastery – critical thinking. Such structured overviews help to make reflected and explicit decisions on the most suitable approach of transdisciplinarity, depending on the goal of a project and the issue at stake.

Yet, Table 1 is not useful for a researcher facing a specific issue like the sustainable development of an informal shack settlement in South Africa or of a touristic valley in the Swiss Alps. If this researcher asks “How do I make a socially relevant and useful contribution through my research?”, then the answer “Make it participatory and integrate disciplinary paradigms!” is not helpful, since it proposes tools without mentioning purposes. In an attempt to reformulate the features of transdisciplinarity as guiding principle from the perspective of the researchers, we identified four such purposes [6,21]: in order to be relevant and useful for societal problem handling, transdisciplinary researchers have to frame, analyze and process an issue in such a manner that

- (1) they grasp the complexity of the issue;
- (2) they take the diverse perspectives on the issue into account;
- (3) they link abstract and case-specific knowledge;
- (4) they develop descriptive, normative, and practical knowledge that promotes what is perceived to be the common good.

The purposes (1)–(3) are not new, but basics of the rationale for transdisciplinarity as a way to address socially relevant issues [9, p. 399]. The promotion of the common good – or more generally speaking the evaluative component of transdisciplinary research – is, however, rarely stated explicitly in definitions of transdisciplinarity, even though it is inevitable in order to assess what an improvement of the current situation is. Purpose (4) means that one of the specific challenges for transdisciplinary researchers is to ensure that value systems do not operate in the shadows and instead are clarified by jointly developing the meaning of, for example, sustainable development for the research project’s context [22].

The four purposes will only be accomplished in the ideal transdisciplinary research process, taking place in heaven. In reality they will not be fully achievable. They might be in conflict and require deliberations and trade-offs. The four purposes are thus a heuristic tool for transdisciplinary researchers—like a compass that shows which way to go as long as you do not get too close to the pole. The concepts A, B and C of transdisciplinarity (Table 1) propose different approaches of how to accomplish these purposes: by integrating disciplinary paradigms; by participatory research; by searching for a unity of knowledge.

3. The concept of thought-styles

The four purposes are guiding principles for a transdisciplinary research process. But they do not say anything about collaboration and integration of perspectives. The following two sections are an attempt to further the understanding of transdisciplinary research as a collaboration of representatives of different thought-styles. The approach of thought-styles is recently applied to study and manage the co-production of knowledge in the field of sustainability and land use [22–25].

The concept of thought-style goes back to the Polish physician and microbiologist Ludwik Fleck. Fleck developed the theory in the first half of the last century, basically by a comparative analysis on how syphilis was conceptualized, researched and cured during the centuries [26,27, pp. ix–xxxiii]. Fleck's approach frames knowledge production as a collective process of historically and socially embedded thought-collectives. At his time this approach opposed the positivist ideas of the *Wiener Kreis* and the idea that philosophers of science should primarily provide intellectual foundations of science, “some *a priori* definition, or ‘demarcation criterion’, like that which Karl Popper has always insisted on” [28, p. 267]. The *Wiener Kreis* was, however, much more influential and popular than Fleck.

According to Fleck [29,30] the ability to distinguish things – to see and to know – is not developed and maintained by an individual person, but by a collective of persons, the thought-collective.

“The sentence ‘John got to know the phenomenon Z’ is incomplete: one has to add to it ‘in thought-style S’, or also ‘from the epoche E’. It is the thought-collective that is the carrier and the author of the thought-style.” [30, p. 98].

The thought-style is characterized by a specific way of looking at the world and distinguishing relevant and irrelevant aspect, i.e., by a specific perspective. For a disciplinary thought-style this includes the state of knowledge, methods, theories, quality criteria and open questions.

“The thought-style is the precondition of collective work in as much as the communally accepted norms are formulated in it – not only about knowledge already examined and taken as secure but also about the methods used in examination, about the criteria for judging what is to be taken as scientifically proven and what as unproven. Furthermore, the thought-style structures the foundation of the work practice of a thought-collective; that is, both what can and must be considered as a scientific problem, and how this problem is to be dealt with” [27, p. xx].

Becoming a member of a thought-collective means to be trained in a specific way of looking at and structuring the world, such as during the studies of organic chemistry, economics or arts. Yet thought-styles are not limited to the academic sector. Religions, a craft or “the practical thought of everyday-life” are thought-styles, too [30, pp. 102–103]. A person does not belong to one thought-style exclusively but to several thought-styles simultaneously. Thought-collectives are heterogeneous communities. Some of its members belong to the smaller esoteric circle “composed of members having a more direct relationship” to the thought-styles products and a larger exoteric circles “composed of members who participate in it through the intermediation of the other ones” [30, p. 101]. The esoteric and exoteric circles are not closed but open to step in or out depending on what a member contributes to the thought-styles development. The thoughts of the thought-styles are not erratic either and change meaning. Fleck names three sources influencing the content of each thought-style: (a) its history including a path-decency of thoughts; (b) the exchange with other thought-styles and (c) the continuous migration of a thought within the collective and being reshaped by its members [30, p. 103].

Kuhn developed the more popular concept of scientific paradigms, which replace each other during scientific revolutions, based on Fleck's thought-styles and thought-collectives [1, p. ix, 27, p. xiii]. Fleck's thought-styles differ from Kuhn's paradigms in a number of aspects that make the thought-styles specifically interesting for transdisciplinary research: people are members of several thought-styles; people might be in the esoteric circle of one thought-style and in the exoteric of another; there are academic as well as non-academic thought-styles; since the thought-styles influence each other there are no boundaries between science and society [31, pp. 318–319]. Hence the thought-styles seem a particularly suitable starting point for describing the interaction of researcher of different disciplines and actors of civil society, the public and the private sector in transdisciplinary research. Participants are seen as experienced in their perspective; as layperson in other perspectives; there is – at least initially – no hierarchical order among the perspectives; and integration and learning takes place through travelling thoughts that change meaning.

Not presupposing a hierarchical order among the thought-styles does not mean to take a relativist position of “anything goes” or to democratise science.² Rather it means to be keen to learn about the different thought-styles and their underlying assumptions. In doing so a solid basis is laid for understanding different knowledge claims, for making informed evaluations of knowledge and for integrating knowledge in transdisciplinary research. Elkana [32–34] makes a useful distinction for that purpose. Accordingly a thought-style is built up of

- a body of knowledge,
- socially conditioned images of knowledge and
- further ideological values and norms, not directly depending on the images of knowledge.

² If a label shall be given to the position taken in the present paper it is rather “enlightenment-squared”.

The body of knowledge is the content of the thought-style: the state of knowledge in the field with its theories, methods, data, solutions, open problem, problem framings and so on. The body of knowledge includes textbooks and papers as well as the knowledge taught in practical courses. The images of knowledge are the implicit assumptions of a thought-collective on its thought-style. They include, among others, the “[b]eliefs held about the task of science (understanding, prediction, etc.), about the nature of truth (certain, probable, attainable, etc.), about the sources of knowledge (by revelation, by ratiocination, by experiments through the senses)” [32, p. 276]. The further norms and values cover more general societal ideologies and the way they shape research, such as the focus on race during the Nazi regime in Germany, or the social ideologies that promote or hinder biotechnological, organic and anthroposophical approaches to farming.

The interesting insight of Elkana’s distinction for the context of transdisciplinary research is that thought-collectives do not only differ in their theories, methods and subject matter but also in the underlying and implicit assumptions building the basement of their perspective. The images of knowledge are not taught explicitly in education. Scholars incorporate them implicitly by familiarizing with the thought-style’s body of knowledge. The biochemical body of knowledge, for example, implies a specific idea of truth and of legitimate sources of knowledge, the same as the sociological body of knowledge or the catholic one. Speaking of beliefs, Elkana accentuates the emotions that are related to the images of knowledge, the gut-feelings. Such gut-feelings are, for example, experienced when reading a scientific paper and thinking “Brilliant, that is how I should analyze the issue!” or when being disappointed or upset by poor science. In Elkana’s terms, being impressed is a sign of a shared image of knowledge. The irritation is either caused by poor science in terms of the same image of knowledge, or by differing images of knowledge. Such images of knowledge are not an additional element in Fleck’s thought-style, but a clarification of what they already include: “Fleck further favourably distinguishes himself from Kuhn by more consciously distinguishing between theoretical products themselves and the convictions, behaviours, attitudes, etc. which scientists form in relation to theoretical results” [31, pp. 318–319].

4. Transdisciplinary research as interacting thought-styles

Fig. 1 shows a transdisciplinary research process as a collective production of knowledge. Involved are disciplinary researchers and representatives of the public and the private sector as well as of civil society. The issue is hunger. The rectangles emblemize the thought-styles of the academic and non-academic thought-collectives.

The participants of a project represent, as Fig. 1 suggests, a particular thought style. In an ideal transdisciplinary research process, these participants provide their body of knowledge in relation to hunger to the collective endeavour. Based on the different bodies of knowledge, hunger is collectively framed, the required knowledge is identified, the problem is analyzed and useful and common good-oriented ways to address it are developed [6,36].

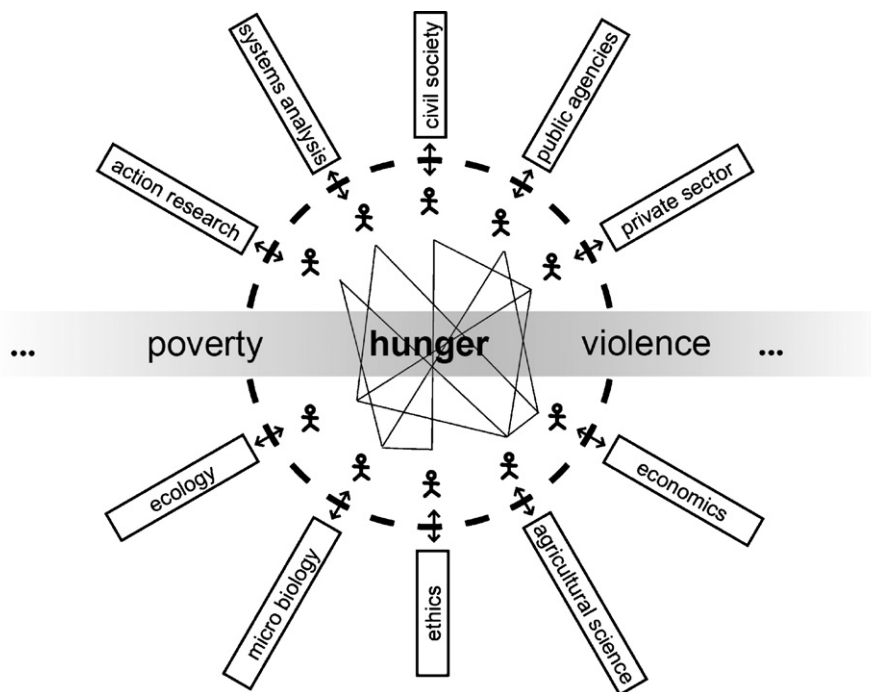


Fig. 1. In transdisciplinary research disciplinary thought-styles (represented by individual researchers) and thought-styles of further sectors of society (represented by individual actors) become interrelated and transformed through co-producing knowledge on a socially relevant issue. A transdisciplinary research project is the system of relations (black lines) built by the collaborative research process [adapted from 35, p. 113].

Fig. 1 is a simplified and idealized model. In reality every participant is a member of several thought styles. The representatives of the system analysis and of the public agency might both be Buddhists. And everybody might be a member of the thought-collective of Swiss citizens. Some of the participants might be members of the esoteric circle and others of the exoteric circle of the thought-style they represent. Some might not know that they are involved in order to represent a specific thought-style. In short, the simplified model does not cover a lot of the challenges related to participation and representation [37]. Still it is instrumental in understanding the integration of thought-styles. Integration is considered as one of the core challenges of transdisciplinary research [38–42]. According to the above defined thought-styles and requirements of transdisciplinary research, the challenge of integration is to interrelate different bodies of knowledge in order to frame, analyze and process hunger such as (1) the complexity of hunger is grasped, (2) the diverse perspectives on hunger are taken into account, (3) abstract and case-specific knowledge are linked and (4) common-good-oriented descriptive, normative, and practical knowledge to address hunger is developed.

For Rittel and Webber [43] hunger is a typical example of a wicked problem. There is no definite formulation of the problem and each problem formulation promotes a specific problem solution [43,44]. If hunger is, for example, framed as a problem of wheat productivity, more productive genetically modified wheat seeds are the solution. If it is framed as a problem of small venture capital, a micro financing scheme is needed. If it is framed as a problem of a land's history of landowning, a redistribution of productive land is the way to go. Based on the concept of thought-styles, the wicked problem is a result of differing images of knowledge. The thought-style's images of knowledge will be expressed in arguing about the relevance of seed productivity, venture capital or land ownership for the understanding and management of hunger. Members of a thought-style are usually not aware of their image of knowledge. They strongly believe that their problem framing and solution is self-evident and that the others will agree after careful consideration. If integration is hindered by such a dispute among thought-styles, the discourse can be shifted to a reflexive level by exploring the underlying images of knowledge. A sophisticated understanding of other thought-styles might build a basis for both re-engaging in or ending collaboration. Elkana [32,33] proposes a number of aspects that a discussion of the images of knowledge could include, such as beliefs about

- the task of science (understanding, explaining, predicting, early warning, providing technologies, ...),
- the nature of truth (certain, probable, attainable, socially constructed, ...) and
- legitimate sources of knowledge (experience, experimental evidence, ratiocination, revelation, authority, tradition, analogy, competence, originality, novelty, beauty, ...).

Elkana's analysis does – like Fleck's analysis – not consider the specific situation of transdisciplinary research: the different thought-styles that deliberately interact in order to jointly address a socially relevant issue. Further beliefs, that might hinder integration, concern the nature and task of transdisciplinary research as well as the role of the different thought styles. Three further starting points for discussing the thought-styles' images of knowledge in transdisciplinary research are thus beliefs held on

- the nature of transdisciplinary research (concepts A–C in Table 1, the five clusters identified by Klein [20], ...);
- the task of the academic and non-academic participants (being interested, using power, subordinating the individual to the common interest, providing value judgments, providing expertise on the issue, ...);
- the task of transdisciplinary research (providing new solutions to problems, providing a comprehensive understanding of an issue, changing thought-styles, modelling possible futures, informing and reflecting policy processes, ...).

5. Progress in transdisciplinary research

Transdisciplinary research is defined here as research that frames, analyzes and processes an issue such as (1) the issue's complexity is grasped, (2) the diverse perspectives on the issue are taken into account, (3) abstract and case-specific knowledge are linked and (4) common-good-oriented descriptive, normative, and practical knowledge to address the issue are developed [6,21]. In a transdisciplinary research project, representatives of different disciplines, of the private and the public sector as well as of civil society co-produce knowledge on an issue, trying to match (1)–(4). Progress can be made both on the level of the issue and on the level of the transdisciplinary research process. Issue related progress means to develop an understanding and management of an issue that fulfils one or several of the purposes (1)–(4) better than the current understanding and management. Transdisciplinary research related progress means to come up with an improved understanding and management of transdisciplinary research processes compared to the present understanding. Both forms of progress can take place on the level of an individual thought-style or on the level of the interacting thought-styles. This results in four kinds of progress of transdisciplinary research:

5.1. Issue related progress on the level of interacting thought-styles

Issue related progress on the collective level takes place if, through the interacting thought-styles, a comprehensive, multi-perspective, common-good oriented and useful new approach to a problem is achieved. Progress is the new handling

of the issue in the real world. An example is the “one medicine” approach [45]. The Chad government was confronted with the problem that the nomadic pastoralists did not use the health services provided to them. Extending over a decade, a research team including expertise in anthropology, medicine and veterinary epidemiology reframed the problem and developed and tested new health services in close collaboration with the nomadic pastoralists, traditional healers and the government. The solution they came up with was “one medicine” health services for nomadic pastoralists and their animals, which traditionally do not separate human and veterinary medicine. The progress in terms of purposes (1)–(4) was reached through the development and implementation of the “one medicine” approach. It was the result of the interacting academic and non-academic thought collectives.

5.2. Issue related progress on the level of a particular thought-style

Progress on the collective level does not mean progress for every individual thought-style. The approach to one medicine, for example, is a progress for the thought-style of the medical and veterinarian medicine, but not for the thought-style of the nomadic pastoralists and the traditional healers. For the latter it is the usual way of approaching health, it is part of their image of knowledge. For the former it is progress because it proposes a multi-perspective and integrated medical treatment by interrelating human and veterinarian medicine. This idea might trigger further progress in the thought-style of medicine, since it offers a comprehensive approach to the analysis and management of zoonoses, i.e., infectious diseases transmitted between humans and domestic or wild animals. Zinsstag et al. made the new way of looking at zoonoses public in *the Lancet*, stating that “simultaneous epidemiological public and animal-health studies provide the approaches to assess the importance and epidemiological links of several zoonoses” [46, p. 2143].

The thought-collective of human medicine might not accept one of its member's ideas as a general progress of the collective. Recalling Fleck's three sources influencing the content of a thought-style – its historical development and path dependency, the exchange with other thought-styles and the continuous migration of thoughts within the collective [30, p. 103] – the innovation triggered by the exchange with the traditional thought-style of the nomadic pastoralists will probably not shake modern western medicine to its core. Still a number of members of the thought-collective of the zoonoses researchers and practitioners might take it up and elaborate the veterinarian and human medicine of zoonoses, making the introducer of the thought a member of the esoteric circle. This would be progress according to Fleck, to whom “progress of knowledge is the collective further development of the thought-style through which the presuppositions on the object of knowledge are shifted” [27, p. xxiii]. It would also be progress in the above-defined sense of transdisciplinary research, since a more comprehensive and multi-perspective understanding is elaborated.

5.3. Transdisciplinary research related progress on the level of a particular thought-style

The transdisciplinarity related progress on the level of an individual thought-style means the lessons that do not have to be re-learned in a next transdisciplinary engagement. The main lesson here is to realize to be a member of a particular thought-style in a plurality of thought-styles. As Giri states in view of our transdisciplinary striving

“The problem with modern disciplinary thinking is that it fails to realise that its claim to universality needs to be relativised by recognising the significance of other disciplines in gaining multiple perspectives about the world to which both one's as well as another's discipline contribute” [47, pp. 105–106].

This is usually experienced in an exchange of different thought-styles. Such an exchange has to overcome the question of who is wrong or right in favour of the question “Based on what assumptions do you come to this conclusion?” The lesson to be learned is that there are alternative images of knowledge underlying the different thought-styles. No sophisticated analysis of the images of knowledge is needed to learn this lesson. It is a general experience that can be made during discussions and debates. Progress means that a member of a thought-style is self-aware of his/her thought-style, familiar with the thought-styles (s)he worked together so far and curious about the thought-styles to come in a next transdisciplinary project.

5.4. Transdisciplinary research related progress on the level of interacting thought-styles

The transdisciplinary research related progress lies in the lessons learned and the experiences gained on the level of the interacting thought-styles. In order to progress, the lessons and experiences have to be transferred to a further project, for example in the form of methods, case studies or checklists. It is the thought-collective of scholars and practitioners experienced in transdisciplinary research and interested in improving it, which is making this progress. Such a thought-style develops an understanding of a transdisciplinary research process and its particular challenges and provides tools and approaches to address these challenges [6,20,36,42,48–50]. With respect to integration, this thought-style will not get around an analysis of the images of knowledge. Paraphrasing Pielke's term, the analytic and synthetic work to do is honest brokering of images of knowledge, rather than honest brokering of knowledge [51]. Some questions that help to progress image-of-knowledge-brokering address the beliefs held on

- the task of science,
- the nature of truth,
- legitimated sources of knowledge,
- the nature of transdisciplinary research,
- the task of the academic and non-academic participants and
- the task of transdisciplinary research.

6. Conclusion

The question of what progress is in transdisciplinary research is answered as follows: if progress through transdisciplinary research is defined as framing, analyzing and processing an issue such as (1) the issue's complexity is grasped, (2) the diverse perspectives on the issue are taken into account, (3) abstract and case-specific knowledge are linked and (4) common-good-oriented descriptive, normative, and practical knowledge to address the issue is developed; if it is further assumed that in transdisciplinary research representatives of different disciplines and of the public and the private sector and civil society collaborate; and if the representatives are furthermore perceived as if they would be members of a specific thought-style in the sense of Fleck, and believe in certain images of knowledge; then four perspectives on four kinds of progress can be distinguished:

1. *A better approach to a specific real world issue:* For some of the collaborating thought-collectives progress is a better approach to a real world issue. It is better in the sense that it fulfils one or several of the purpose (1)–(4) more than the present handling of the issue. There is no specific interest from that perspective to search for general patterns of that specific progress. The interest is in making it happen.
2. *Progress within a thought-style:* Transdisciplinary research might trigger progress in a specific thought-style, in the sense that the new approach to an issue fulfils one or several of the purposes (1)–(4) better than the present approach, like in the “one medicine” example. Here examples of case studies could serve as tools for how to make progress in (1)–(4). Progress for transdisciplinary research would mean to have a structured sample of good case studies and to make (critical) thinking in analogies part of education.
3. *Experiencing and internalizing the membership to a certain thought-style and the plurality of thought-styles* is a third kind of progress. Progress for transdisciplinary research would be if the positioning of the thought-style in relation to others becomes part of general education and special training and of the thought-styles' body of knowledge.
4. *A better understanding and management of transdisciplinary research* is, to my current understanding, a progress for a thought-style of its own. This thought-style is currently evolving and forming, including disputes whether a transdisciplinary discipline would not be a contradiction in terms.³ Note that such a thought-style in Fleck's sense does not necessarily mean “a discipline”. It might also materialize as a profession, a community of practice [52] or as a secret society. The dispute about this question among the future members is on its way. My conclusion for such a thought-collective's work on integration is that it should take a closer look at the thought-collectives' underlying assumptions—the images of knowledge. Progress means that the members of that thought-collective achieve a sophisticated understanding of, and become experienced in managing the participants' diverse images of knowledge.

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³ Gabrielle Bammer's presentation on integration and implementation sciences and on dialog-methods at the td-conference “Integration in Inter- and Transdisciplinary Research”, 19th–21st November 2009 at University of Berne, Switzerland, triggered a controversial debate about whether or not there should and could be something like a discipline of transdisciplinarity.

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