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Toolkit on Transdisciplinary Education and Science

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1 PART ONE: DEFINITION

The complexity of major global challenges such as climate change, migration, global health, and urbanization, requires universities and teaching institutions to innovate their education offers by fostering collaborative and participative approaches. Whereas interdisciplinarity aims on an enhanced coaction between disciplines, *transdisciplinarity* seeks to describe, recognize and explore knowledge and proficiency across, over and beyond (lat. *trans*) disciplines (lat. *disciplinae*). Its core idea is to create strategic research alliances between university and society: faculty staff members work together with experts and practitioners from politics, culture, industry and civil society to develop sustainable technologies and solutions to today's challenges (Vilsmaier 2021).

Transdisciplinary education promotes a "new production of knowledge" (Gibbons et al. 1994), and by giving favor to experimental and transformative research designs, it can be described along five central paradigms. Fundamentally, it includes the many attempts to shape research and reflection processes together with society through dialog and to integrate the (1) *plurality of knowledge resources* – including professional knowledge, everyday knowledge, and implicit knowledge – from politics, civil society, business, and culture into the academic learning process. Consequently, practicing transdisciplinary education requires universities to accept and emphatically affirm the (2) *plurality of actors* in the process of knowledge production, among them stakeholders from civil society, industry representatives, political experts alongside researchers from universities. Transdisciplinary education is further characterized by a (3) *plurality of participation opportunities* to guarantee access to a broad audience, far beyond structural hindrances such as campus architecture, admission rules and funding policies. Collaborative practices and methods such as citizen science, fablabs, do-it-yourself cultures, real life labs are just some of the new arenas of collaborative knowledge cultivation. Despite the augmentation of its members, it remains important to accept their varying profiles of expertise, power, and accountability: Transdisciplinary education presupposes a comprehensible discernment within the (4) *plurality of tasks and renegotiation of roles of responsibility.* The degree of liability, and duty of care of the members is different. Finally, transdisciplinary learning requires to accept the (5) *plurality of educational biographies and knowledge paths*: Different ways may contribute to reach a learning goal, and transdisciplinarity demands participants to embrace detours, failures and flops.

The specifically *plurality* character of transdisciplinary education provides students with the framework to distinguish between knowledge-based resources, consider their use for specific issues, and find ways to integrate these sources of knowledge into their studies and research. At the same time, students learn about their responsibility to communicate with society and to open avenues to allow them to share their own learning experiences and research results with society (Philipp/Schmohl 2021).

2 PART TWO: INSTITUTIONAL AND STRUCTURAL MEASURES

Guidance for university management and policy makers

2|1 Augment Career Relevance

Lacking career opportunities are major hindrances in cultivating transdisciplinary education. In most European countries, such as Germany and Austria, access to a professorship depends on the amount and quality of scientific publications, whereas the experience with participatory research formats and education capabilities generally plays a less important role. Thus, transdisciplinary education requires a fundamental shift of mentalities and recognition cultures: it must become crucial to (1) *value transdisciplinary competences and experiences* in appointments to chairs and in case of academic teaching staff vacancies. Beyond the criterion of publication performance, selection committees have to acknowledge a future professor's transfer networks and to take into consideration all didactic experiences at the threshold between university and society: Does the applicant possess personal contacts to stakeholders, civil society and industry representatives? Has he or she proven records in managing complex research projects with a variety of societal actors?

Furthermore, the establishment of (2) *teaching awards* is a cost-effective, easy and impactful way to establish transdisciplinarity competencies as a part of a successful academic career. Beyond financial categories, annual teaching awards for transdisciplinary projects stress the institutional shift towards a broad recognition of transdisciplinary education activities. At the same time, they establish a communicative resonance chamber to exchange views and experiences of transdisciplinarity within the university's staff member community. To foster reflection, (3) *annual conferences on transdisciplinary education* can contribute to the required culture of change. These measures should be generally accompanied by efforts to strengthen internal communication to promote best practices and success stories.

2|2 Boost Motivation and Ensure Quality

To augment the motivation among students to participate in cooperative teaching formats, universities must consider the need of (1) individual *science coaching* offers for students: The goal of such dialogic and individual measures is to provide individual guidance to learners and support them in managing their curriculum in the most promising way: which competences are lacking? How can I improve my cooperation with society? Which decisions should I take, when it comes to course registration and studies abroad?

On the level of teachers, (2) *colleague advice and peer counselling* as well as (3) *professional development and training* for teaching staff members will further strengthen the motivation and competencies. An internal (4) *contact and activities database* can help to identify external experts who could contribute to a project with their expertise and to get in touch with them. To facilitate an efficient discernment and identification of external actors, a (5) *sound documentation of transdisciplinary activities* (exhibits, web, publication, social media) and a (6) *regular impact evaluation* are important framework conditions. One additional structural investment towards a long-term institutionalization of transdisciplinary education is to establish the position of an (7) *advisor for transdisciplinary education* on faculties or universities level. Since all of these structural measures can cause uncertainty among employees and introduce profound change in work processes, self-perceptions and institutional cultures, the university management should also consider a professional (9) *change management* in order to avoid conflicts at an early stage and not neglect the needs of any university member.

2|3 Improve remuneration structures

Remuneration is a significant part of acknowledgement culture. Transdisciplinary education projects often result in a highly increased workload for their initiators, as they require large time investments and organizational experts. This includes additional tasks such as network building and maintenance, arrangements with external stakeholders, preparation of the spatial siting of courses, etc. It is therefore necessary to (1) *ensure funding for augmented workload* for teaching staff and, in addition, to (2) *compensate the time investments of external experts* financially.

2|4 Improve Curriculum Development

Inter- and transdisciplinarity are still mostly a phenomenon of application rather than of reflection. Many study programs claim to be inter- or transdisciplinary, but an adequate reflection about the experiences and challenges about transdisciplinary working are lacking. Transdisciplinary education however needs a constant and systematic reflection about curriculum development and about the sense, goals and limits of transdisciplinary methods within a study program (Kelly 2009, Jenert 2014). The central task therefore is to (1) *introduce curricular reflection phases* for disciplinarity, inter- and transdisciplinarity into all study programs. On a much more ambitioned level, complex and difficult in its implementation, the university can also consider to (2) *set up a faculty for transdisciplinarity*. Although such an institutional measure appears utopian and unrealistic for the most universities, reference models like the Leuphana semester at Leuphana University Lüneburg show at least the feasibility of introducing a mandatory inter- and transdisciplinary first semester for all students of all disciplines.

3 PART THREE: INDIVIDUAL MEASURES

Guidance for teaching staff

3|1 Discern techniques of transdisciplinary education

To make university teachers part of the transdisciplinary experience, communicative efforts and professional training is needed to provide overview about the broad panorama and the high creativity of transdisciplinary methods. Some examples: (1) *Service Learning* offers students demand-driven research projects at the interface between classroom learning and local stakeholders field expertise, particularly in environment related urban problems (Dolgon et al. 2017). Their particular added value is to provide not only scientific, but also social and personal learning outcomes (Yorio and Feifei 2012). (2) *Citizen Science* enables citizens to become active participants in a scientific research process (Kullenberg and Kaperowski 2016, Stilgoe 2009). Its areas of application initially were only natural sciences (e.g., bird protection), but were extended later also on archaeology, rather rarely social sciences, such as action research and democracy research. Whereas citizen science projects initially only involved citizen as data providers, recent approaches also involve citizens in co-creating the research design (Newman et al. 2012, Cavalier and Kennedy 2016).

(3) *Internships* are a widespread and accepted method to extend the academic learning experience on a practical field. In most cases, however, they are not recognized as transdisciplinary measures, and reflection spaces to merge systematically scientific (classroom) knowledge and practical professional knowledge are lacking. However, the potential to involve students in a transdisciplinary didactic experience through internships is high.

Substantial learning opportunities in terms of transdisciplinarity can be explored in (4) *Living Labs or Real World Labs*: integrated research and innovation processes between university and local stakeholders in a public-private-people partnership (Schäpke et al. 2018). Research does not take place any more in closed labs: society itself is the new “lab” to develop sustainable solutions, e.g., in urban development, waste management, circular economy, etc. Although the research in living labs has grown in importance over the last years, the involvement of students remains often poor. Most living labs are rather research than education oriented. The task therefore is to open the living lab culture to a learning arena for students.

Several universities, such as TU Berlin, institutionalized (5) *Science Shops* during the 1980ies. Their central goal is to provide participatory research support in response to industry or civil society concerns, particularly with regard to environmental conflicts, urban development. consumption, or sustainable innovation. Task, mission and size of a science shop vary widely from university to university. Their capability to contribute to transdisciplinary education depends on their degree of student involvement.

(6) Student centered learning and project-oriented programs offer a major opportunity to experience transdisciplinary individually on any chosen topic (Barrett 2005, Braßler and Dettmers 2017). The idea is easy: Any student can set up a project workshop with other colleagues or stakeholders. It permits studying without any professors or research assistants, accompanied only by a tutor. Students choose their topics by themselves and earn a creditable certificate at the end of their 2-year experience. Project-oriented studies provide students with the chance to collaborate systematically, independently and responsibly with external stakeholders on a given real world problem.

A rich resource for learning at the crossroads of science and society is the increasing number of (7) *do-it-yourself cultures* and their manifold communication and practice spaces. Repair cafés, where users and experts fix technical devices together, and community gardens, are just one of many examples for a cooperative problem solving with various actors of knowledge production involved. Also general transfer activities as (8) science communication can provide a promising practice to cultivate transdisciplinarity competencies: Within a science communication course, e.g., students learn to communicate innovatively

their scientific findings to a broad public. It is evident that many of these seminars require a duration of two semesters or longer, as the short window of one semester is insufficient to work on the additional tasks such as acquiring partners and finance, arrange meetings and define a research objective etc.

3|2 Establish collaboration with practice experts

Many universities maintain liaison offices to intensify their communication and collaboration with external actors from public administration, politics, enterprises. As transdisciplinarity requires networks and access to external experts, academic teachers rely on the support of the university's liaison office, whose aim is to enhance cooperation and communication between university members and alumni. Transdisciplinary formats such as service learning and project-oriented learning can be facilitated by strengthening the links between university staff members and students on the one side and alumni, graduates, young entrepreneurs, etc. on the other side.

3|3 Reform teaching attitudes

Transdisciplinarity presupposes systemic change in various ways, particularly in basic teaching attitudes and understandings of didactics. Teachers must be willing to (1) *reduce control*, if they want to allow a free (inter)play of creative forces. Transdisciplinarity is based on engagement to (2) *activate participation and co-creation* on the threshold. As a consequence of acknowledging the plurality of knowledge paths, it is essential to (3) *embrace failures, flops and detours* of students, learners and teachers. In the end, transdisciplinarity practices will also change given structures in universities and contribute to (4) *dismantle hierarchies and extend collective responsibility*. (5) *Reflective and metacognitive practices* must be established, respected and defended. And finally, in view of the plurality of actors involved, transdisciplinary practices require a sound and systematic (6) *feedback literacy* to ensure that lessons from the cooperation with the practical sphere are learned and adequate measures to meet future didactic challenges are taken.

4 CONCLUSION

This overview has shown that the panorama of transdisciplinary education is broad. It covers manifold learning areas and fields of didactic creativity. This toolkit is intended to be used by different levels, from top management to individual teachers and students. Our hope is to inspire academic education from a transdisciplinary way of thinking and to provide innovation to universities and their educational culture.

This toolkit is going to be published on the ENHANCE website.

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