TRANSFORMATIVE INNOVATION LAB

HANDBOOK TO FACILITATE STUDENTS' REAL-WORLD LABORATORY PROJECTS TO PROMOTE TRANSFORMATIVE AND TRANSDISCIPLINARY COMPETENCIES

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FOREWORDS

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Dear Reader,

When it comes to contributing to sustainable transformation, institutions of higher education and higher education itself have both an opportunity and a responsibility. As places of knowledge generation, they can help develop strategies for sustainable transformation of the societies in which we live. They can also create the educational formats needed to train key actors in sustainable transformative change who are both willing and able to participate in shaping the much-needed transformation of the economic system and of society as a whole.

Students play a key role as potential *sustainability change agents*. As such, they must be made familiar with the change-ability of complex systems so they can adequately perceive and understand both society and its development. They also require the necessary knowledge and tools to be able to actively shape that development.

Programmes must thus be created and tested, and their impacts researched, that build bridges between disciplinary knowledge and specialised expertise on the one hand, and a problem-oriented, interdisciplinary approach on the other. Especially promising formats in this regard are ones which succeed in creating transdisciplinary contexts that promote the integration of a variety of knowledge resources, including practice-relevant transformation knowledge and the consideration of such real-world fields of application.

With the Transformative Innovation Lab, a programme has been devised in which students are introduced to systems thinking and working with transdisciplinary approaches and methodologies in the form of hands-on practice in *real-world labs*. It is hoped that the experience gained in this project will be widely shared and used in the further development of higher education for sustainable development.

I wish you the courage and commitment needed to share and implement that knowledge.

Professor Matthias Barth
(Leuphana University of Lüneburg,
Institute of Integrative Studies)

Dear Reader,

The multiples crises of our times highlight the need for us to rethink education if we want to enable people to rise to the global challenges of sustainable development in a reflective and solution-oriented way. In addition, the increasing societal polarisation of sustainability discourses, science scepticism and fake news give rise to a new set of challenges for socially engaged, transformative research. For higher education, these crises and trends give rise to a range of opposing positions: hands-off theory versus hands-on practice, disciplinary inwardness versus transdisciplinary openness, autonomous research based on personal interests versus responsive involvement in transformation processes at local level.

The Transformative Innovation Lab project has taken a productive approach to these opposing positions, casting them in a teaching format that combines their various and sometimes ambivalent goals. It has enabled students from two different Master's programmes to experience the ambitious goals of this form of higher education for sustainable development first-hand, allowing them to develop transdisciplinary key competencies and empowering them to shape transformation in their capacities as *change agents*. This aim implies not only the development of a professionally sound knowledge of transdisciplinary and transformative research, but also the creation of spaces where that knowledge can be applied, reflected upon and consolidated. That the students were able to experience a high degree of self-initiative, co-determination and self-management is symbolic of the high quality of the learning spaces created as part of the project. And the fact that teamwork and collaboration with non-university partners played such an important role in that process shows that societal transformation is difficult to achieve alone.

This handbook looks at the key findings of the Transformative Innovation Lab project. It invites readers to reflect and perhaps embark on their own research journey to explore how innovative formats for (higher) education for sustainable development can be integrated into their own study programmes or learning spaces. It also sets out an understanding of science and education that – notably where universities and societal partners interconnect – encourages both experimental learning and learning experimentation about and for sustainability innovations.

Experience gained at those points of interconnection is what leads us away from familiar paths of thought and action, what strikes us as dissonant and makes us question everyday things. Transformative learning processes can thus be promoted by creating suitable spaces to reflect on those dissonances and the emotions they arouse. In the realm of the ideal, those transformative learning processes – some of which I believe the Transformative Innovation Lab project has already brought about – would promote reflexivity and creativity, generating new knowledge for use in shaping sustainability transformation. And in times of multiple crises, they would help us to cope with the opposing positions in higher education, find a balance between them and still be able to act in a reflective way.

I wish you an interesting and informative read, and trust you will share widely the wealth of inspiration that this handbook reveals.

Dr. Mandy Singer-Brodowski
(Freie Universität Berlin, Institut Futur –
Education and Futures Research Division)

WHO THIS PUBLICATION IS FOR

This handbook is intended to encourage and support teachers and facilitators at universities and at other educational institutions to work with students to

- understand and shape future-oriented processes of social transformation,

- meet the local-level challenges of sustainable development, collaborate with local practitioners on concrete issues

- and – as sustainability change agents – initiate change processes by means of their own transdisciplinary and transformative research and innovation projects.

The Transformative Innovation Lab (TIL) gives students the opportunity and the space to explore their own researcher identities and to reflect, conduct independent research and try things out, also testing themselves in the process. They can work as part of a transdisciplinary learning group and use additional training and tutoring programmes to prepare for their Master's thesis.

This handbook shows how all of this can be achieved and guides facilitators through the development and implementation processes step-by-step. It first outlines the starting situation in terms of pressing sustainability issues and international discourses. This is closely linked with the *transdisciplinary and transformative research landscape* that has developed since the 1990s with the aim of providing input for concrete solutions and thus to generate adequate and *socially robust knowledge*. These approaches form the basis for the current *real-world lab* discourse and are addressed in Section 2 in conjunction with the *education for sustainable development* approach and the skills that are needed in shaping processes towards sustainability and change. It looks at why universities and students can and should play a pioneering role in sustainability transformation in both research and its application. This is rounded off with details of related, successful pilot projects in other higher education contexts which served as sources of inspiration for the TIL. Section 3 takes an in-depth look at the Transformative Innovation Lab concept, which is largely based on the phased, methodological, academic and personal mentoring of students in their own transdisciplinary and transformative real-world lab projects. Each of the steps is explained, elaborated on and enriched with suggestions for teaching and learning. In Section 4, the focus is placed on practice and the establishment of such teaching and learning formats at universities and other higher education institutions, and the experience gained in two separate TIL programmes.

Note: The two TIL pilots conducted at the two participating universities were developed long before the corona pandemic began and were near to completion in March 2020. Despite the strong focus on local contacts and activities in students' individual projects, the tutoring and exchange components were tested during the pilots as blended learning formats both offline and online. Various modules can thus be flexibly deployed, including in distance study phases. In addition, both the content and the practice-related architecture of the TIL show that beyond the pandemic situation and despite its prolonged impacts, the pressing issues of social justice and environmental sustainability will remain with us and continue to challenge us both personally and professionally for the longer term.

Context: the EEVA project

This handbook was developed as part of the EEVA project *(Development, testing and dissemination of new qualification offers for 'change agents' for transformative learning using the real-world laboratory approach).*

The project's main aim was to develop a conceptual framework for a *Transformative Innovation Lab* (TIL) that can be integrated in modular form into Master's programmes, test it over two study programmes and cohorts, and adapt it on the basis of the experience gained. The goal and the purpose of the module is to give students the knowledge and tools and ultimately the skills to enable them to perform independent, transdisciplinary and transformative research into sustainable development – in other words, for them to act as 'sustainability change agents'.

Further project aims were to promote interchange between actors from sustainability research and different educational sectors and to advocate the module's implementation at other universities and other educational institutions. Another objective was to develop a (digital) interactive simulation role-playing game that introduces and fosters an appreciation of the challenges and the systemic complexity involved in sustainable development.

The project was conducted under the leadership of the Wuppertal Institute for Climate, Environment and Energy in close collaboration with Freie Universität Berlin and Leuphana University of Lüneburg and ran from October 2017 to December 2020. It was funded by the German Federal Environmental Foundation (DBU).

Further information is available at
www.transformative-innovation-lab.de/en

PILOT	TEST & EVALUATE	CONNECT & DISSEMINATE
Development of conceptual framework	Test (across two cohorts in two study programmes)	Conference with disseminators, publications and presentations

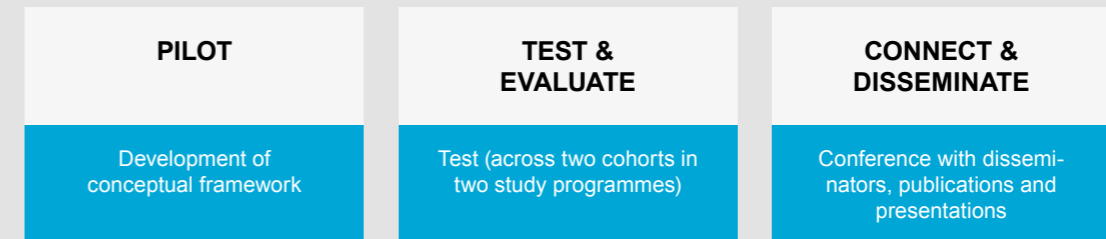*Figure 1: Overview of the project modules*

LEARNING

SUSTAINABILITY

1. LEARNING SUSTAINABILITY: BEGINNINGS AND CHALLENGES

Despite a range of global advancements on the way to a liveable and intact world (UN, 2015a), socio-environmental topics such as poverty, inequality, resource use, biodiversity loss and climate change continue to be pressing and all too often growing problems (Steffen, Broadgate, et al., 2015; Steffen, Richardson, et al., 2015). The resolution of issues relating to sustainable lifestyles and the socio-environmental transformation of society (WBGU, 2011) is becoming increasingly urgent and affects not only issues concerning a 'good life', but all human existence.

Against this backdrop, the international community in 2015 adopted the *Agenda 2030 for Sustainable Development* – a plan for fundamental improvement in current and future lifestyles and the protection of natural resources (UN, 2015b). The Agenda contains 17 *Sustainable Development Goals* (SDGs, see Fig. 2) which are linked to urgently needed action in all countries of the world.

The central aim is to achieve, within planetary boundaries, the transformation of society which meets socially acceptable standards and makes it possible for all population groups to earn a decent living (UN, 2015b).

 For this to be achieved, all social actors must work together across disciplinary, sectoral and institutional lines. Central importance is attached to science and education, and especially higher education with its university teaching and learning formats (UN, 2015c, 2015b; WBGU 2011).

The UNESCO Global Action Programme on *Education for Sustainable Development* (ESD) (2015-2019) had the goal of enabling people to think and act in a future-focused way and to recognise the connections between action and its associated global and intergenerational impacts (BMBF, undated). This is further built upon in the follow-on ESD programme, *Education for Sustainable Development: Towards achieving the SDGs* (ESD for 2030) (BMBF, 2020). ESD for 2030 focuses on using education for sustainable development to help achieve the sustainable development goals contained in Agenda 2030. It also cites the social and psychological preconditions seen as key prerequisites for transformation (BMBF, 2020).

"Empowering learners to […] drive transformation" (BMBF, 2020) is to be promoted in a targeted way. To contribute to sustainable social development, it is necessary to develop an understanding of the complexity, uncertainties, trade-offs and risks associated with the sustainability challenges faced at both global and local level (Leicht et al., 2018). Education for sustainable development thus focuses on developing the *key competencies* (see Section 2.2) that enable every individual to participate in socio-political processes and to help shape and guide societal development processes in a sustainable direction.

In addition to the policy framework at global, European, national and regional level, new alliances and collaborations between social actors are needed along with technical, social and systemic innovations.

Ultimately it is individuals who, through their own actions in the settings in which they live and work, initiate processes of change and with them sustainability transformations (Schneidewind, 2018, p. 452). In this way, social actors become 'sustainability change agents'. These play a pioneering role and possess specific skills and abilities to promote and guide large-scale transformation (Brundiers & Wiek, 2017; de Haan, 2008; Kristof, 2010; Wiek at al., 2011). This means that it is not only in the context of the *third mission* that universities and other higher education institutions make suitable education venues for socially relevant, reflective approaches using methods of transdisciplinary and transformative research. The real-world lab approach (see Section 2.1), which is based on transdisciplinarity and transformative research, is a fruitful construct in this regard. Real-world lab approaches offer the opportunity to take the sustainability debate not only into the environmental but also into the socio-political context, to jointly develop sustainable strategies to solve concrete issues and problems, and thus to contribute to the implementation of Agenda 2030.

As a result, the aim of the Transformative Innovation Labs project is to promote the real-world lab approach in higher education for sustainable development and to encourage students to become 'sustainability change agents' by planning and implementing real-world labs of their own.

Figure 2: The Sustainable Development Goals. Source: www.un.org/sustainabledevelopment/

TRANSFORMING
SOCIETY

2. WHAT IS NEEDED FOR A SUSTAINABLE TRANSFORMATION OF SOCIETY: RESEARCH APPROACHES AND KEY COMPETENCIES

The Transformative Innovation Lab (TIL) operates at the intersection between an experimental mode of innovation and transformative learning for sustainable development. Its aim is to integrate the real-world labs research approach into higher education and by doing so to help students acquire sustainability-related competencies.

The TIL operationalises "real-world learning opportunities" (Brundiers et al., 2010) in a research-oriented or practice-oriented way. The role of educators then not only comes down to subject-matter expertise, which students have to acquire anyway in their real-world experiments in a highly self-organised manner, but also to mentoring and coaching in important learning experiences (Thomas, 2009).

Building on this, the two subsections that follow set out the theoretical and conceptual foundations of the TIL. Section 2.1 explores the distinctions and links between *Mode 2 science, transformation research* and *transformative research, transdisciplinarity, real-world laboratories* and *futures studies.* Section 2.2 presents *transformative education and learning processes* together with the key competencies that accompany them.

2.1 Transformative research: key theoretical foundations

The question of how science can contribute to surmounting the global challenges described in the previous section is a leitmotif of sustainability research and has led to a profound reflection process within the scientific community, especially since the 1990s. Building on action research, solution-oriented and interventional research designs were discussed and developed in what is known as *Mode 2 research* (Gibbons et al., 1994; Nowotny et al., 2001; Schneidewind et al., 2016). Mode 2 research is based on the observation that the second half of the 20th century saw a strong shift away from the classical relationship between science and society, with science no longer operating in isolation from society, but increasingly influencing society and itself being influenced in turn by societal processes. This Mode 2 science differs from classical Mode 1 science in a number of ways.

Classical Mode 1 research is organised strongly along disciplinary lines and addresses problems specified from within the scientific community. Its aim is to produce scientifically validated knowledge. In the authors' opinion, this mode of research has increasingly been supplemented by new forms of knowledge production in Mode 2. These new forms of knowledge genesis address societal problems in interdisciplinary settings and are directed at generating socially robust knowledge. In such interdisciplinary and transdisciplinary settings (see below), science not only acts as a producer of validated knowledge ('truth'), but increasingly also assumes a role as 'knowledge advocate and knowledge broker' (cf. Nowotny et al., 2004; Schneidewind & Singer-Brodowski, 2013).

Transdisciplinary research in detail
Transdisciplinary research essentially has three characteristics:

- Transdisciplinary research addresses problems relevant to society,

- enables shared learning processes and integrates knowledge from scientists in different disciplines and notably also from outside the scientific community, and

- aims to produce solution-oriented, socially robust knowledge that can be transferred both into society and into science.

The illustrated ideal-typical model of transdisciplinary research based on Lang et al. (2012, see Fig. 3) is considered seminal to the understanding of transdisciplinary research processes. According to this model, transdisciplinary research processes can be divided into three main phases:
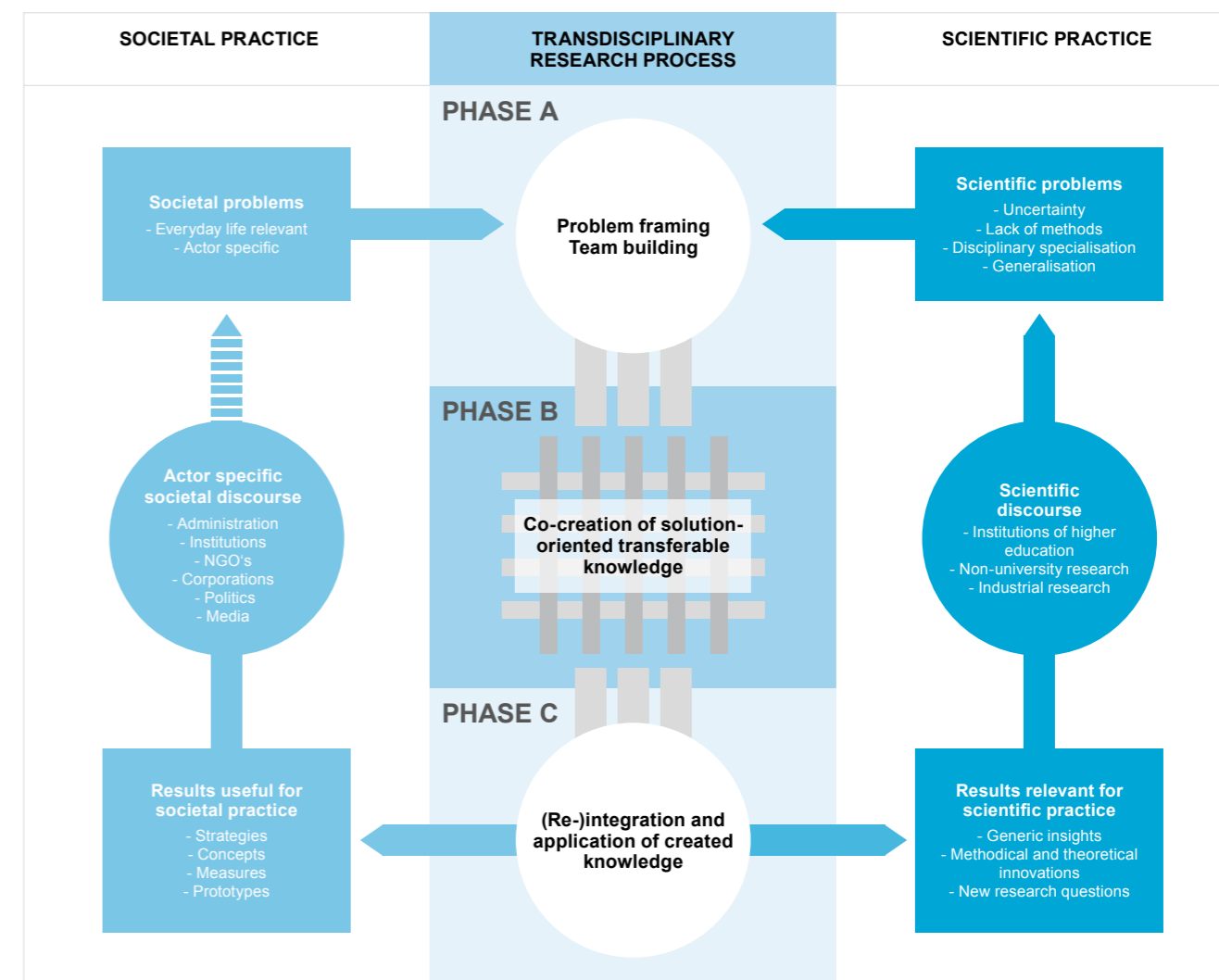

Figure 3: The transdisciplinary research process in detail. Graphically adapted on the basis of Lang et al. (2012)

Transformative research as a contribution to sustainable development

The distinction between transformative research and transformation research was coined by the German Advisory Council on Global Change (WBGU, 2011). In its flagship report, the Council states that the aim of transformative research is to try out sustainability solutions in interventions and to learn in the course of application. It identifies the focus of transformation research, on the other hand, as being to understand both causal factors and drivers of and obstacles to transformation processes and from them to draw conclusions about future developments and how to shape them (WBGU, 2011, pp. 321 ff.).

Three forms of knowledge are distinguished in the context of the two lines of research: *System knowledge, target knowledge* and *transformation knowledge* (see Fig. 4). While system knowledge that provides 'objective' understanding of systemic relationships continues to be produced, other aims are also pursued. These include the generation of target knowledge, meaning knowledge about desirable and hence normative futures. Research on and about these two forms of knowledge tends to take place in transformation research and to be descriptive and explanatory. The third form of knowledge, transformation knowledge, extends far into the territory of transformative research, where context and actor-specific knowledge about possibilities for shaping transformation processes that are effective in terms of sustainability is tested, developed and applied in experimental processes.
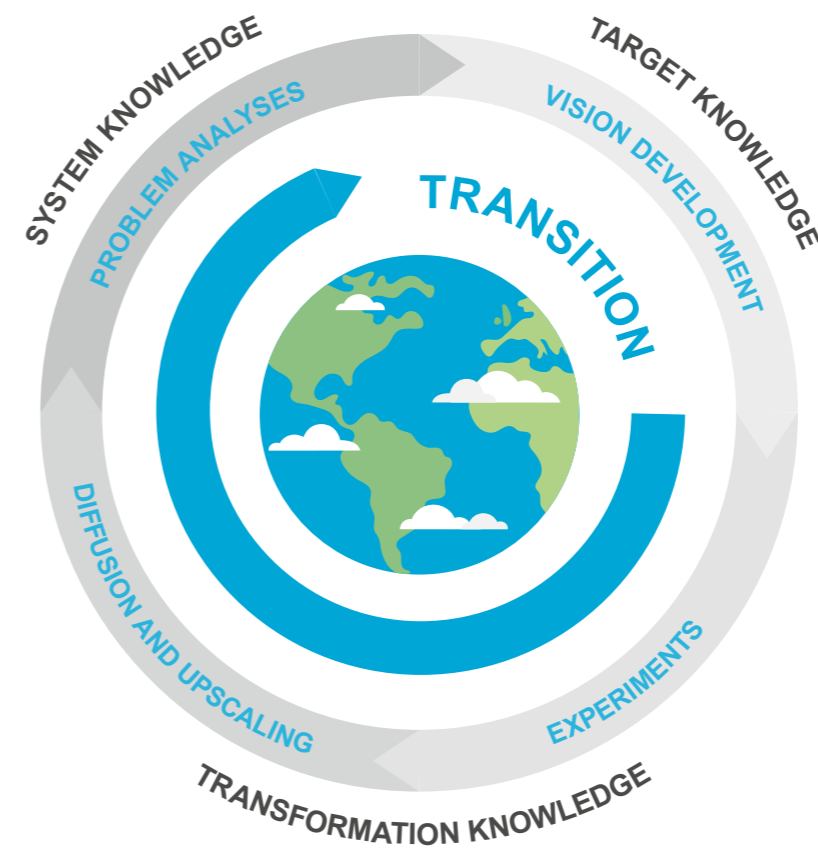

Figure 4: Forms of knowledge in transformative research
Source: Wuppertal Institute (undated), graphically adapted

Phase A: Based on societal challenges and research questions, the first phase primarily serves the purpose of specifying and framing a shared understanding of a problem and building a suitable project team.

Phase B: The aim of the second phase is to integrate different bodies of knowledge in order to co-create solution-oriented, transferable knowledge. This involves specifying the roles and responsibilities of the researchers and the contributors from outside academia. The shaping of transdisciplinary settings and the selection of (frequently participative) research methods also play a key role. In line with the self-reflexive nature of the transdisciplinary research approach, the setting and methods are continually adapted to the ongoing research process.

Phase C: The final phase is about reintegrating and applying the knowledge integrated in the research process. This two-dimensional reintegration transfers the knowledge back to the scientific community and to societal practice. In the course of this, targeted products are developed for both dimensions and evaluated for their societal and scientific impact.

Other key aspects of transdisciplinary research practice are *formative evaluation* and conflict resolution. The focus here is on critically monitoring the research process at all times, verifying goal attainment and, if necessary, adapting to changing circumstances.

Real-world laboratories as a setting for transdisciplinary and transformative sustainability research

Primarily in the last few years, the real-world laboratories approach has been discussed and refined in the context of the generation of transformation knowledge and related experiments (MWK, 2013; Schäpke et al., 2018; Schneidewind, 2014; WBGU, 2016, p. 512). Real-world laboratories systematically connect transdisciplinarity and transformation research, and mark the intersection between transformation research and transformative research. The focus of real-world laboratories is on experimentation, meaning applying integrated knowledge and cyclic learning on the basis of that knowledge in the course of the research process (see Fig. 5). The chart shows the ideal-typical process of a real-world lab with the phases co-design, co-production and co-evaluation. This process logic guided the conceptualisation of the learning phases in the TIL as set out in Section 3.

In this process, real-world laboratories follow an approach of transdisciplinary collaboration between scientists and (local) practitioners, integrating different forms of knowledge and jointly organised participation and learning projects, including in the form of exploratory learning. Research in real-world laboratories mainly takes place in context. This context-boundedness notably also enables ongoing (self-)reflection and evaluation in order to repeatedly challenge the research processes, adapt to new conditions and spark innovations. Real-world labs are therefore education settings for transformatively oriented, transdisciplinary sustainability research. They thus broaden the previous customary focus of transdisciplinary research processes, which is mainly on integrating and synthesising knowledge for potential application.

Futures studies: a closely related research area

One research area closely related to transformative sustainability research is *futures studies*.

Firstly, approaches and methods from this research area enable the systematic generation of target and transformation knowledge. This includes exploratory approaches such as scenario techniques that ask what futures are possible or probable from a systemic perspective. Use is also made of normative approaches that ask what futures are desirable and, by methods such as *backcasting*, are able to show potential paths for target attainment and possibilities for change. A particularly important aspect in both cases is that futures studies approaches assume plural futures and therefore leave the discussion open to uncertainties and surprises. Thinking in scenarios also opens up other possibilities of deliberative decision-making for real-world experiments and sustainability decisions (regarding deliberation see, for example, Kowarsch et al., 2016). In line with this,

futures studies approaches also speak about creating orientation knowledge, which is closely linked to target and transformation knowledge (Grunwald, 2014). Here, too, the Mode 2 science debate fundamental to transdisciplinary research underpins the conceptual foundations of the research area.

Secondly, there are overlaps with futures studies approaches that focus on shaping change processes such as, among others, the *futures action model* (Ramos, 2017) and *experiential foresight*. These can provide, for example, ideas for real-world experiments and interventions that aim to make possible or attain other futures and have strong connections with participative formats and action research.

Thirdly, integrating futures studies supports the training of anticipatory competence. There is a large overlap here with the area of *futures literacy*, meaning the ability to understand the role of conceptions of the future in shaping the present, to conceive of futures as something that can be shaped and to take an active part in shaping them.
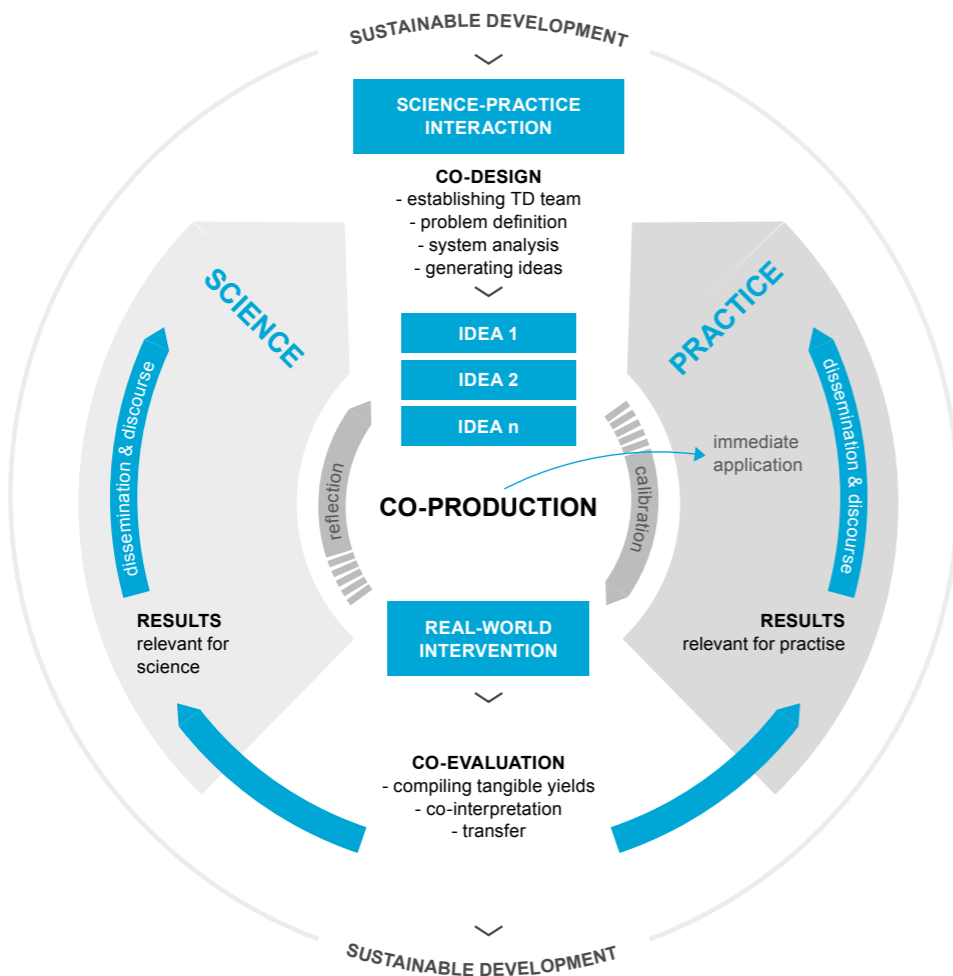

Figure 5: Concept for a transdisciplinary and transformative real-world lab process focused on learning from experiment. Graphically adapted on the basis of Wanner et al. (2018)

2.2 Transformative education and learning processes and transformative competencies for promoting sustainable development

Discourses on education for sustainable development, transformative education and transformative learning

Education for sustainable development (ESD) is deployed today as a "concept in many educational institutions" (Singer-Brodowski, 2016a, p. 13) with the aim of promoting sustainable development in society (Rieckmann, 2016). The UN Decade of ESD (2005-2014) and the ensuing UNESCO World Programme of Action (2015-2019) have resulted in the increasing integration of sustainability goals in, for example, curricula and examination outcomes at educational institutions ranging from daycare centres to universities (Brock et al., 2018). This is now being reinforced in the recent ESD follow-up programme, *Education for Sustainable Development: Towards achieving the SDGs (ESD for 2030)* (UNESCO, 2019). ESD for 2030 places the focus on education for sustainable development for attainment of the Agenda 2030 Sustainable Development Goals (SDGs) (UNESCO, 2019). Alongside the ESD approach, there are also other concepts that emphasise educational activities as a central lever for sustainability transformation. The German Advisory Council on Global Change (WBGU, 2011), for example, also advocated concepts of *transformation education* and *transformative education* in parallel to those for research referred to in Section 2.1. Transformative education here places the focus on enabling an "understanding of different options for action and solution approaches" (WBGU, 2011, p. 352) and describes individuals as "change agents" (WBGU, 2011, p. 243) who play a pivotal role in launching and shaping change processes.

Both approaches attract criticism, however. ESD is often questioned for featuring a frequently top-down implementation approach and a relatively weak concept of sustainability. To remain "eligible for funding and support", educators and their institutions are seen to have been encouraged to temper any criticism of existing economic models (Getzin & Singer-Brodowski, 2016, p. 38). Proposed solutions are found to be more "symptomatic than causal" with insufficient attention given to growth-critical and postcolonial perspectives (Getzin & Singer-Brodowski, 2016, p. 37, after Selby & Kagawa, (2018)). Most ESD approaches also restrict themselves to the level of action in the private sphere and so undermine the potential for public action and strategic analysis of effective ways to address a problem (Chawla & Cushing, 2007).

The concept of transformative education is criticised for the fact that education is always transformative in any case, in that it changes thinking, consciousness and, in the best instance, behaviour (de Haan, 2019). However, transforma-tive education places a greater focus on encouraging transformative action (Singer-Brodowski, 2016a). A potentially problematic aspect here is that strong doctrinal opinions – in the area of sustainability as elsewhere – can constitute indoctrination and subjectively overwhelm students' ability to form their own political judgement, in contravention of norms such as the *Beutelsbach consensus* underlying political education in Germany (BPB, 2011). In addition to this fundamental criticism, it is also argued that transformative education is based on a strong concept of transformation without, however, demonstrating any foundation in education science (Singer-Brodowski, 2016a).

By contrast, the concept of *transformative learning* established in education science is operationalised educationally and methodologically (Getzin & Singer-Brodowski, 2016). It encompasses two broad directions: "the approaches of transformative learning as a change in individual perspectives of meaning and the concepts of transformative learning as collective processes of awareness development and emancipation" (Singer-Brodowski, 2016a, p. 15). In transformative learning, crises and/or experiences of (successful) failure result in the questioning of basic understandings and the creation of new realities (de Haan, 2019; Singer-Brodowski, 2016b). Transformative learning thus goes beyond the mere acquisition of knowledge and abilities to trigger changes in basic behaviour, feelings and thoughts (Singer-Brodowski, 2016b).

The transformative learning discourse originated in the domain of adult education (Mezirow, 1991). The approach is based on the premise that learning individuals have assumptions and expectations – about themselves and the world – underlying the subjective meaning perspective that governs how they perceive and interpret information. Transformative learning focuses the process of building awareness of, questioning and further developing the individual's own meaning perspective (Getzin & Singer-Brodowski, 2016). This can take place by way of project-oriented formats, by way of collective practices that can be incorporated into everyday life, and also by way of critical discussion. Other methods that can be used to foster these processes include the use of diaries, role-playing, perspective exercises, social simulations, 'living statistics' or systemic constellations to gain a better understanding of the complexity of interrelationships. The conceptual approach of transformative learning – in contrast to transformative education – includes the discussion of growth-critical and ideology-critical perspectives. In addition, structural possibilities for transformation towards sustainability are identified that go beyond what people can do at the individual level (Singer-Brodowski, 2016a).

The overarching goal is, firstly, greater reflexivity. This is achieved by encouraging critical thinking or the adoption of a critical perspective on current societal developments. Secondly, transformative learning aims for a change in awareness on the part of learners and the development of a changed relationship to the world. Transformative learning theory thus takes up the points that are criticised with regard to transformative education and education for sustainable development.

In more popular science terms, Schneidewind writes that transformative learning can be regarded as an "interplay of knowledge, mindsets and skills" (Schneidewind, 2018, p. 461; see Fig. 6). Those mindsets must be underpinned by a guiding sustainable vision and an appetite for change. Changing individual or collective behaviour requires abilities, a perceived sense of potency or ability to act and certain key competencies, which are discussed below.

The TIL ties in with the perspective of transformative learning and is directed at designing a learning and education format that remains free from indoctrination and enables active intervention in societal processes.
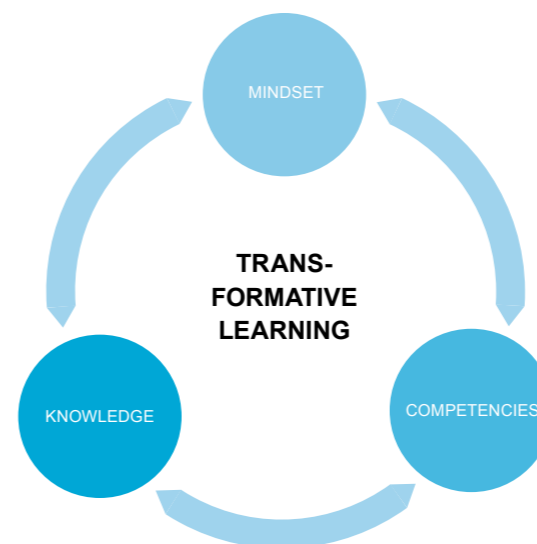

Figure 6: Interplay between mindset, knowledge and skills as key dimensions of transformative learning, graphically adapted and translated on the basis of Schneidewind (2018, p. 461)

This is achieved by fostering reflexivity and enhancing effectiveness by means of transformative research. The TIL aims to help close gaps that remain in the university context. It also pursues the aim of enabling learners to "acquire the knowledge, skills, values and mindsets that empower them to contribute to sustainable development" (BMBF, 2017, p. 8). The key competencies enabling students to contribute to sustainable development as change agents are the subject of the discussion in the following.

Key competencies in the context of sustainability

In a review of teaching and learning approaches in academic sustainability education, Wiek et al. (2011) identified five key competencies that enable students to understand and shape sustainability and transformation processes. Those competencies are 1) *strategic competence*, 2) *systems thinking competence*, 3) *anticipatory competence*, 4) *normative competence* and 5) *interpersonal competence*. These key competencies make it possible, on the one hand, to analyse the current and past complexity of interrelationships between different structures and to predict developments and, on the other hand, to develop visions of a sustainable future, transformation strategies and interventions, to subject them to critical appraisal and to communicate them to society in a targeted manner.

In order to attain a sustainable real-world goal, *strategic competence* is used in planning and implementing interventions and transformation strategies. This entails developing effective projects, programmes and policies and formulating a plan for the coordination of activities between departments or organisations in joint projects or programmes.

Such strategies aim to change the current state of the socio-ecological system. The second key competence, *systems thinking*, involves understanding the complex systems of problems both in the status quo and in their genesis. It provides the ability to assess the causes, dynamics and potential knock-on effects of different systems and interrelationships. Potential obstacles and long-term consequences should also be taken into account in strategy formulation and strategies adapted as a result.

Anticipatory competence includes analysing, evaluating and developing visions of a sustainable future. This requires creative skills and methods of scenario analysis and simulation. It provides the ability to anticipate unintended harmful consequences and developments regarding future generations and hence take them into account in the planned intervention.

Normative competence is used to verify that a project is developing in the desired direction. Sustainability values and goals are collectively specified in advance. This requires knowledge of justice, equity, social-ecological integrity and ethics. This competence thus serves the purpose of weighing the direction and orientation of change between desirable and undesirable states and developments and of assessing a project's sustainability performance.

A final important focus in the development of collaborative, participative solutions for sustainability problems is on *interpersonal competence*. This is an integral element of the remaining competencies. Sustainability challenges are mostly triggered by the fact that there is interaction between many different parties with differing perspectives, interests and priorities. These various positions need to be understood. There is consequently a need for advanced communication and negotiating skills, expert knowledge, empathy and experience in working in teams and with stakeholders with differing socio-demographic backgrounds, knowledge, preferences and attitudes.

The TIL is aimed at students nearing completion of a Master's programme and represents a potential gateway to sustainability professions. It is therefore important also to address relevant professional skills that are necessary and/ or helpful in this regard. For these professions, Brundiers and Wiek (2017) have identified six helpful professional skills and tested them in teaching. Those skills are 1) *preventative self-care*, 2) *effective and compassionate communication*, 3) *collaborative teamwork*, 4) *responsive project management*, 5) *impactful stakeholder engagement* and 6) *advanced continuous learning*. Some of them overlap significantly with or complement the five key competencies. The skills of preventative self-care and effective and compassionate communication, for example, enhance interpersonal competence.

Both the key competencies and these skills were instructive in designing the individual educational components of the TIL, as set out in Section 3.

Formats such as the Transformative Innovation Lab empower students to develop key competencies with which they can act as change agents in a transformative and transdisciplinary way. Through transformative learning, they are strengthened in their reflexivity and learn to determine their own meaning perspectives and to develop the interplay of attitudes, competencies and knowledge.

2.3 Transformative learning processes in higher education: importance, role and good practice

Approaches to transformative learning and thus to TIL address two virulent problems in the current structure of higher education and in knowledge genesis for sustainable development:

- Firstly, the approach addresses the *theory-practice gap* and the *accumulation of inert knowledge* (Gruber et al., 1999), because experimental learning in real-world labs motivates people to test prior knowledge and derive new knowledge from practice.

- Secondly, the TIL fosters a more pronounced culture of successful failure. Deviations from plan and unexpected events are not the exception but the rule. In the tradi-

tional science system, it is usually only successes that are recorded. Important lessons from failed attempts go unnoticed or are even concealed. But in the TIL, the idea is to focus on the context, generating patterns of change along with alternative perspectives and strategies – not least by learning from failures and mistakes.

In developing the TIL, motivation and inspiration were found and taken from a variety of projects and formats that have already sought and found (partial) solutions to the challenges outlined above. The following introduces various examples of good practice in higher education where teaching is approached and implemented in a real-world, transformative way.
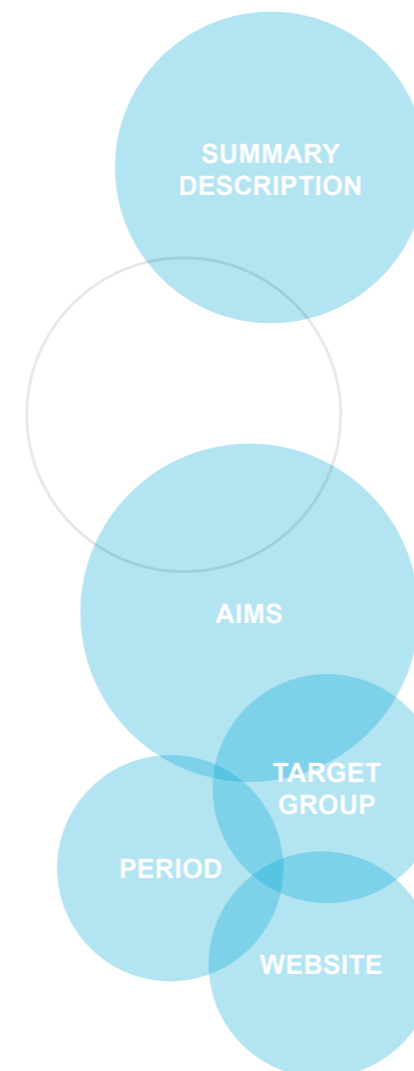
THE CHALLENGE LAB | Chalmers University of Technology
Gothenburg (Sweden)

SUMMARY DESCRIPTION

When working on transformative research and innovation projects, Master's students from various disciplines tackle the question of how transitions to a societal future can be shaped in such a way that they are mindful of planetary boundaries.

Focus is placed on examining the challenges of sustainable development from a systemic perspective and promoting skills for leadership in sustainability transformations and in stakeholder management for sustainable development.

Implementation of transdisciplinary research projects is based on the backcasting principle, which guides the entire laboratory process. Basically, this involves specifying problem-oriented sustainability criteria, describing the current situation on the basis of the specified criteria, developing visions for the future and devising strategic measures to achieve the sustainable development goals.

AIMS

- Serve as a hub for and creator of regional knowledge clusters
- Promote collaboration between universities, private industry and the public sector
- Train and prepare students for their roles as change agents

TARGET GROUP

(International) Master's students, 15 students per programme

PERIOD

Two semesters per programme since 2014

WEBSITE

www.challengelab.chalmers.se/

GLOBAL CLASSROOM AND MASTER'S IN GLOBAL SUSTAINABILITY SCIENCE

Leuphana University, Lüneburg (Germany)
Arizona State University, Tempe, Arizona (USA)

SUMMARY DESCRIPTION

Funded by Stiftung Mercator, the Global Classroom project was jointly conducted by Arizona State University, Tempe, and Leuphana University, Lüneburg. It was designed to bring students from differing cultural backgrounds together in a shared, digitally supported, transdisciplinary learning space. Over the course of four semesters, Bachelor's students worked in small teams to apply problem-based methodologies to tackle real-world challenges of sustainability and cultural research in Lüneburg and Tempe. The local-global ('glocal') learning space focuses on a range of learning areas, each of which includes additional aspects – exploring the local environment, developing a research design, implementing research, communicating research results/knowledge transfer.

The Global Sustainability Science Master's programme builds on the ideas of the Global Classroom and offers students from Leuphana University and Arizona State University the opportunity to obtain a double degree Master's qualification. Students complete three semesters at their home university and one semester at the partner university abroad. Here, too, students tackle the key problems of the 21st century in their research work. The main focus is placed on issues concerning sustainable development (e.g. climate change, energy supply, food security) combined with the question of social and environmental policy provisions and strategies that lead to sustainable development paths. Teams work with stakeholders to find solutions in real-world contexts.

AIMS

- Training of change agents for the creation of global networks featuring cross-cultural skills
- Development and refinement of sustainable solutions in collaboration with social actors within and beyond the research community
- Analysis of cultural and epistemological foundations of sustainability in a complex, globalised world

TARGET GROUP

Bachelor's students in various major's study programmes (Global Classroom), (international) Master's students, 10 students per cohort per university

PERIOD

Global Classroom programme (two cohorts from 2013-2015)

Leuphana: Six seminar modules integrated into the Bachelor's programme over three semesters with 30 ECTS

Arizona State University: Four semesters, students from different disciplines

Since 2015: Double degree Global Sustainability Science Master's programme: Four semesters, three in Lüneburg, one in Arizona.

Focus on key competencies of sustainable development (Wiek et al. 2011, see Section 2.2).

WEBSITE

www.leuphana.de/en/research-centers/cgsc.html

THE INNOVATION LAB SYSTEM

Wuppertal Institute for Climate, Environment and Energy / Centre for Social Investment and Innovation (CSI), Heidelberg University (Germany)

SUMMARY DESCRIPTION

The project and the lab were designed to provide abilities and skills for young innovators in Europe's energy sector.

The aim was to understand complex system relationships, looking at them from different cultural and industry-specific angles, develop European visions, generate and implement system innovations and prototype solutions for sustainable energy systems, and initiate processes of change.

The lab's structure included the teaching of theoretic background knowledge and the following modules: Co-Design (essays, visioning, storytelling, serious gaming), Co-Creation (design thinking, roadmapping, collective leadership, roleplay) and Co-Sustaining (mentoring, journaling/dialogue walks, graphic recording, feedback).

AIMS

- Creation of a network of system innovators to attain a sustainable energy future
- Development of a better (scientific) understanding of the concept of system innovation
- Contribution to the transformation of Europe's energy system

TARGET GROUP

Young and mid-career professionals who work in Europe's energy sector and who will in future play the role of decision-makers on energy-related matters in government, industry, civil society and academia.

PERIOD

2016: Kick-off seminar (six days in Berlin), exploration phase (local, 10 weeks, nine EU countries), reflection phase (five days in Warsaw)

WEBSITE

www.soz.uni-heidelberg.de/csi-transdisziplinaere-vermittlung/system-innovation-lab/

beFORE – BECOMING FUTURE ORIENTED ENTREPRENEURS IN UNIVERSITIES AND COMPANIES | Freie Universität Berlin, Institut Futur, funded by Erasmus+ (Poland, Italy, Spain and Germany)

SUMMARY DESCRIPTION

As part of the project, modules were developed to train academics as future-oriented entrepreneurs in a university and business context. Between 2017 and 2019, 10 project partners from various institutions (universities, companies, non-university research) and four EU countries developed an online educational programme. The resulting e-learning platform is designed to provide knowledge and action skills focused on shaping the future/future development (futures literacy) and promoting the ability to deal with uncertainty in times of rapid change. Six modules were developed. Key topics include futures studies theory and practice (e.g. methodologies and tools), sustainable development, change management and the practice of systems thinking. The platform is freely accessible and can be used for self-study.

AIMS

- Promote and expand futures literacy in students, entrepreneurs and academics
- Integrate the foresight approaches/methodologies used in futures studies into other academic disciplines
- Give individuals and organisations the tools they need in preparing for the future

TARGET GROUP

Students

Employed academics/teachers/researchers

Entrepreneurs

PERIOD

Four-module foundation course over a total of 18 hours

Three modules for advanced participants, one module for each of the target groups: Students (8 hours), academics (6 hours) and entrepreneurs (6 hours)

WEBSITE

www.futureoriented.eu

TRANSFORMATIVE
INNOVATION LAB

3. THE TRANSFORMATIVE INNOVATION LAB

The Transformative Innovation Lab (TIL) project aims to integrate the real-world laboratory approach (see Section 2.1) into higher education. The labs operate at the intersection between experimental innovation mode and transformative learning for sustainable development. The objective is to create real-world learning spaces, integrated into existing teaching modules, which both enable analysis of change processes from a systemic transformation perspective and promote the development of key competencies for their strategic design (see Section 2.2.).

The core of the TIL concept is the integration of theoretical/methodological knowledge, experience and reflection: In a TIL, students learn about the thematic complexes of sustainability and transformative research and are encouraged to specifically address system, goal and transformation knowledge in the course of a self-selected project. This is supplemented with methodological perspectives of transformative, transdisciplinary and futures research. Designing and carrying out a (small-scale) mentored transformative research project of their own provides students with an opportunity

to apply theory and gain hands-on experience. This give-and-take between theory and practice is backed up with numerous opportunities for (individual and group) reflection. This not only enhances students' learning experience, but also enables them to take a critical view of their own abilities and skills, and of the transformational influence of their own actions. In implementing the TIL, these aspects are partly linked and partly addressed in specific units, as illustrated in more detail below.
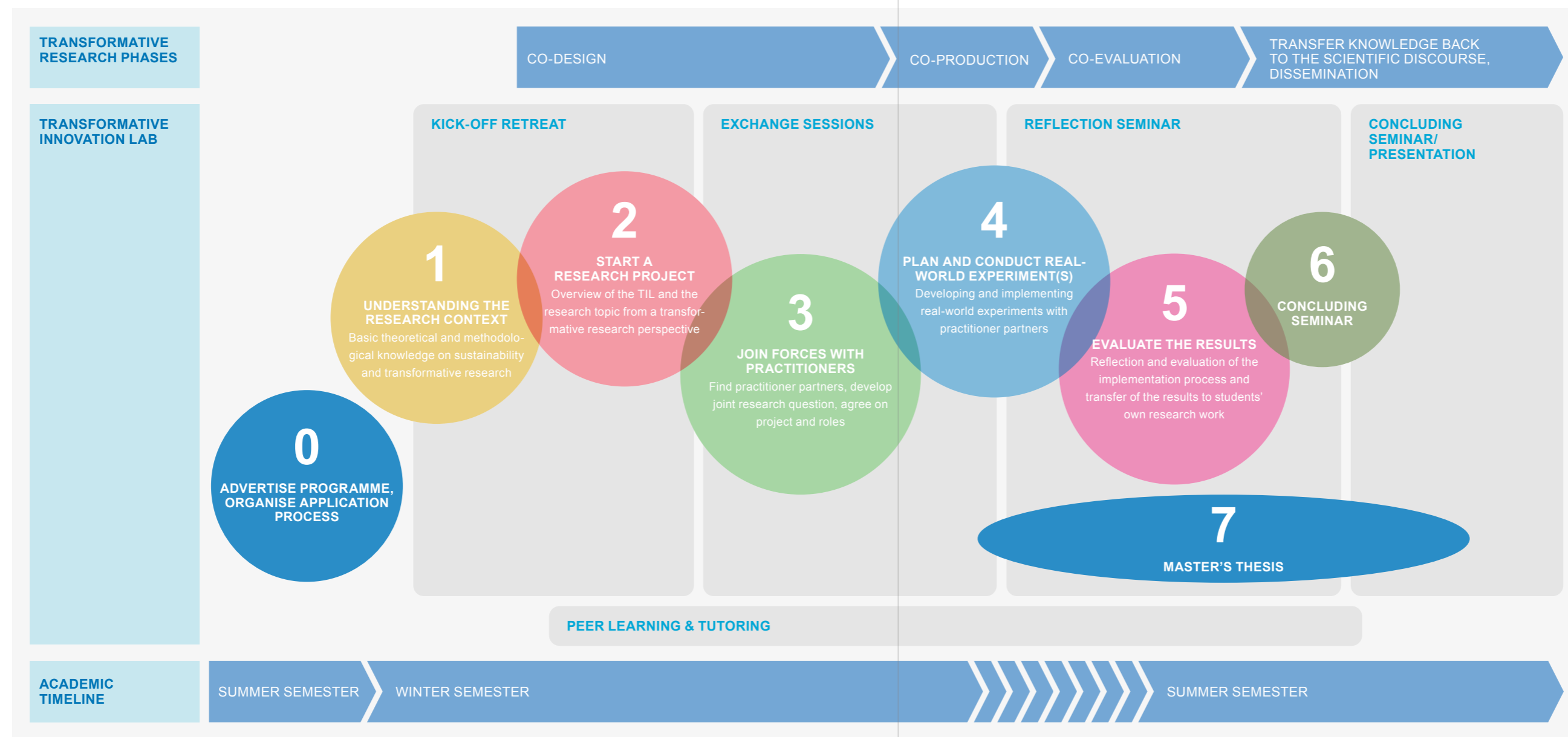
Figure 7: Integrated schematic of an ideal-typical TIL. The individual phases of the TIL are shown in the coloured circles at the centre. In the grey-coloured background, the event formats are shown as they are deployed over the course of the project. With regard to methodology, the transformative research phases are outlined in the upper bar, while the lower bar shows the chronological sequence, broken down by parts of the academic year. Further details can be found in the text.

3.1 TIL design and process: transformative research within existing education formats

Rather than developing new educational paths and qualifications, the TIL is designed to integrate transformative research into the learning environment of existing study programmes (see Section 4.1). Working alone or in small teams, students conduct (small-scale) transformative research projects and are mentored at each step of the way by peers and lecturers. The TIL also gives students the opportunity to use their research project as an experimental Master's thesis to gain a deeper understanding of real-world laboratory research. A TIL's design and process is thus geared to the semester structure and focuses on the real-world lab research phases (see Fig. 7).

A TIL runs over two semesters and is designed to take place in the third and fourth semesters of a Master's degree programme. The duration of a TIL can be influenced, however, by students' prior knowledge, any existing research involvement and, in particular, the complexity of the envisaged projects and whether they are intended for use in a Master's thesis.

Although teaching, experience and reflection are all linked within the TIL, their relationship shifts in the course of the two semesters. In the first semester, for example, the focus is on teaching theoretical and methodological basic knowledge, with students starting a research project and, in parallel, co-designing it together with practitioners. Depending on the study programme and examination requirements, interim results during this phase can take the form of a project report, a portfolio or an exposé for a Master's thesis. In the second semester, the main focus is on implementation (co-production) and co-evaluation, for example as part of a Master's thesis. At the end of the second semester, students round off the TIL by completing their project assignment. Students are mentored by teaching staff for the duration of the TIL.

SPOTLIGHT: TIL PILOT PROGRAMMES AT FREIE UNIVERSITÄT BERLIN AND LEUPHANA UNIVERSITY LÜNEBURG

Freie Universität Berlin, Futures Studies Master's programme
The TIL was integrated into *Module 8, Project Internship* in which students gain practical experience and are given the opportunity to conduct their own (applied) research projects. The project internship module is intended to last 400 hours and is supplemented with an accompanying colloquium. The module (15 credit points) ends with a report and is not graded. The TIL was able to be fully credited towards the module as an individual research project.

Students from the Master's in Futures Studies participated in the two programmes – one group of 10, the other of seven. The students applied in writing, stating their reasons for wanting to participate in the TIL and giving their preferred areas of interest/research field.

Students' project partners included Fridays4Future, an organic bakery, a project consortium for home energy generation, a neighbourhood committee for mobility issues and Teach First Fellows for a project on LGBTQI-related topics. All project partners were approached by the students themselves.

Although most students decided in favour of an intervention, they decided against working on and presenting the results in a Master's thesis.

Leuphana University Lüneburg, Master's Programme in Sustainability Science
Implementation of the TIL was tested at Leuphana University Lüneburg in two different modules: In the first cohort, the TIL was offered as a supplement for second semester students in a *transdisciplinary project* (seminar programme over two semesters with 10 credit points and 300 hours each). The nine students participating were able to use the TIL to develop their own research projects for their Master's thesis alongside the local transdisciplinary case study conducted as part of a group. Participation in the TIL was not assessed separately. It was integrated into the work conducted in and partly overlapped with the local case study. As not all participants in the transdisciplinary project took part in the TIL, the approach proved to be confusing for students in some respects and was revised for the second cohort.

For the second cohort, also of nine students, the TIL was offered as a stand-alone programme as part of the *Master's Forum Module*. The Master's Forum Module assists students in planning and compiling their Master's thesis and ideally ends with completion of a scientific exposé on their research project. The TIL shifts the focus of the Master's Forum to the development phase of the Master's thesis. At Leuphana University Lüneburg, the module carried five credit points (150 hours). The examination required a combined research paper presented in the form of a lecture and a written exposé.

The students established project partnerships with the project Zukunftsstadt Lüneburg 2030+ (www.lueneburg2030.de), the local green electricity provider Lünestrom, representatives of local owner-operated retail outlets and a neighbouring church congregation, among others.

3.2 TIL formats: giving change agents the skills and abilities they need

By conducting real-world experiments in collaboration with practitioners, students contribute directly to the initiation of change processes in society and promote the experimental operationalisation of knowledge on sustainable development in a practical, hands-on way. Rather than perceiving them as competitors, stakeholders see students as challenging, dynamic actors (Larsson & Holmberg, 2016). This enables a sphere of trust to be built, thus paving the way for sustainability innovation. And students are afforded the opportunity to initiate and accompany innovative processes as change agents for sustainability transformation.

This underlines the importance of teaching key competencies and skills for change agents (systems thinking, anticipatory, strategic, normative and interpersonal competencies as well as preventative self-care, communication, teamwork, responsive project management, stakeholder engagement and continuous learning skills, see Section 2.2). Imparting such skills and competencies requires that students be given the opportunity to obtain hands-on experience, both in a sandbox setting and in a real-world context, and to reflect on that experience individually and as a group. The TIL is thus seen as a trusted learning space in which students are invited not only to explore transformative research but also their own research identity. By participating in the TIL, students can assess whether working as a change agent in transformative research matches their research identity and/ or if they wish to pursue that line of research further. They also reflect on and expand their soft skills (e.g. moderation, communication and teamwork skills, stress-resistance). The TIL addresses students as individuals and repeatedly invites them to reflect on their strengths, fears, motivation and learning experience and, should they wish to do so, test their own limitations.

In the TIL, various formats are used that make it possible to combine this kind of reflection on one's own abilities, motivation and emotions with acquisition of the methodological and theoretical knowledge needed to carry out a research project and scope for implementation and experimentation. The chosen formats offer part-virtual, part-real-world settings and a fruitful interplay between the synchronous and asynchronous phases of the teaching and learning process that takes place in the lab. This happens in a mix of inputs (from educators and guest practitioners), excursions (e.g. visits to current real-world labs), time for students' own projects, guided exercises, reflection sessions and experience reports from students. Group elements play an important role in creating a trusted space in which to experiment, reflect and learn, foster exchange and, where appropriate, form teams to work on research projects. It is recommended that the TIL be conducted with interdisciplinary groups of participants, for example in cooperation between study programmes. Particular attention can – and should – then be placed on interdisciplinary exchange and reflection on (subject-specific) fundamentals such as theories, methodologies and models.

The key components of the TIL:

- A **kick-off retreat** over several days at a non-university learning venue that marks the academic, group and individual beginning of the transformative research projects.

- Over the course of the TIL programme, **exchange sessions** are held on topics matched to where the students are in the process, both as in-person events (including students from different universities, perhaps combined with reciprocal visits) and as online formats.

- The **reflection seminar** at the transition from design to implementation is aimed at presenting the individual learning process on the way to becoming a sustainability change agent and critically questioning that process. This can be repeated at the end of the TIL if desired.

- The **concluding seminar** held once the projects or Master's theses are finished and in which the graduates complete the TIL programme together by (publicly) presenting their research projects – ideally with their practitioner partners. This also provides an opportunity for experience-sharing both between TIL cohorts and between pioneer practitioners and policymakers.

In addition to these shared events, students are continuously mentored throughout the TIL programme. Mentoring includes:

- **Peer learning**: During the kick-off event, students form (interdisciplinary) teams/tandems who support each other in a self-organised way for the duration of the lab and also learn from one another through mutual exchange. Regular exchange and mutual feedback with the group as a whole is an integral component of the lab and is made possible through the use of online communication channels and messenger apps.

- Regular **colloquia** provide students with a platform to present topics and progress made in their transdisciplinary research projects or Master's theses, and to resolve both subject-specific and formal issues. In addition, individual **tutoring formats** are offered during the course of the lab to provide mentoring during research projects and Master's theses and foster interdisciplinary exchange. Ideally, such formats are already provided for in the study programme modules into which a TIL is to be integrated.

3.3 TIL modules: mentoring students through each phase of their transformative research project, providing specialist knowledge, experience and opportunity for reflection

The following modules outline the core components of the TIL that play an important role in the phased mentoring of students through their transformative research project over two semesters (see Fig. 7). They are presented in a mix of methodological and theoretical knowledge, self-experience, skills acquisition and reflection. However, they are merely intended as guidance with regard to possible modules. They can (and should) be adapted in form and content as required (see also Section 4).

The exercises, reference literature and materials contained in the modules can be viewed at (some in German):

www.transformative-innovation-lab.de/en/handbuch
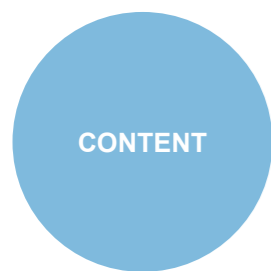
0 ADVERTISE PROGRAMME, ORGANISE APPLICATION PROCESS

CONTENT

In this phase, the special module should be advertised as part of the study programme; where appropriate, students should be approached in person. A low-threshold application procedure, e.g. via a one-page, informal motivation letter ensures that students' previous interest is retained. Whether or not hard selection criteria are used depends largely on the applicants-to-places ratio. In the pilots, every applicant was accepted.
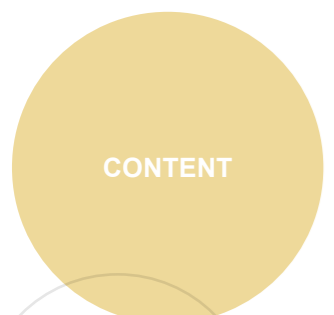
1 UNDERSTANDING THE RESEARCH CONTEXT | Basic theoretical and methodological knowledge on sustainability and transformative research

CONTENT

This module provides, suitably adapted to students' prior knowledge, the **theoretical and methodological knowledge base needed to conduct a transformative research project in the context of sustainable development**. New topics are linked to prior knowledge, which is actively introduced. Core topics for the **knowledge base** to be acquired:

- Background on and basic concepts of sustainability, e.g. strong/weak sustainability, World in Transition, the Sustainable Development Goals (SDGs)
- Theoretical and methodological approaches to change processes in the context of sustainable development – e.g. multi-level perspective – and of (normative) design and focus, for example backcasting and scenarios
- Background on transformative research and (ideal-typical) research designs and methodologies, especially real-world labs
- Distinctions between action research, transformation research, transformative research and change management
- Transdisciplinary and interdisciplinary approaches and the different bodies of knowledge (system, target and transformation knowledge)

Of central importance is that students become aware of the **system complexity**, the dynamics and the conflicts of interest that go hand in hand with sustainable development and transformative research. They also experience **transformative research as a living research field** which invites both practical and theoretical participation in shaping it.

The knowledge to be acquired is closely linked to reflection. Students reflect on their own discipline and the associated views concerning transformation processes and sustainability, and on their personal views and motivation. Normative objectives and implications, including the student's own, are also examined. The normative orientation of transformative research requires sufficient space for reflection and also paves the way for the differing roles that researchers adopt in the course of real-world laboratory work (see role clarification below).

LEARNING OBJECTIVES

- **Provide knowledge** on the subject of sustainability and foster an understanding of the challenges faced in the pursuit of sustainable development. Given the thematic diversity involved, such knowledge can only be conveyed at a basic level and in the form of an overview. Students' prior knowledge is extremely helpful at this stage.
- **Create knowledge** of theories, methodologies and (ideal-typical) research models for transdisciplinary and transformative research and science. Recognise the differences between transformative research and transformation research.
- **Reflect** on participatory skills, needs and opportunities from a systemic perspective and, in this context, reflect on one's own motivation.
- **Focal competencies**: Systems thinking, normative competence, interpersonal and interdisciplinary competencies, communication skills.

OPTIONS FOR ACADEMIC IMPLEMENTATION

- Provide methodological-theoretical knowledge via a **mix of inputs (from educators and invited practitioners) and the retrieval and inclusion of students' prior knowledge**. For interdisciplinary groups in particular, explicitly incorporate specific prior knowledge, e.g. by having students talk about their own discipline and how it links to sustainability and transformation. Play buzzword bingo to collect and work together on key but possibly unclear concepts, thus gamifying exchange and mutual learning. Joint (visual) development of, for example, ideal-typical research designs can also be useful where prior knowledge exists.
- **Foster an appreciation of system complexity in a sustainability context.** As part of the project, the Centre for System Solutions (CRS) in Poland was able to further develop *The World's Future*, a web-based live social simulation. The simulation playfully illustrates the complexity, needs and limitations of governance for sustainable development, humanitarian development and planetary boundaries. In multiplayer mode with all students playing, it highlights the conflicts of interest that arise in the pursuit of differing sustainability goals and strategies. Through roleplay, students experience the importance of collaboration and communication first-hand.
- Provide and effectively moderate **room for critical debate**. Students should question sustainability as a thematic complex, individual theoretical/methodological approaches and the relationships between them, looking at them from different angles and taking them on board.
- **Create personal links to the context of sustainability and transformation**, for example by asking students to introduce themselves, cite personal links to sustainable development/the SDGs and explain their motivation in applying to participate in the TIL. This provides personalised points of departure for the theoretical content, supports group formation and creates a basis for personal reflection.
- **Enable self-reflection of one's own participatory motivation**, for example via the *meet the descendants* exercise used in deep ecology (Macy & Brown, (1998)), where 'time travelling' students report on the things they encountered in the future.
- With familiarisation exercises, warm-ups, group components and not least through one's own open mindset, **create a trusted space that encourages learning and experimentation.**

RECOMMENDED FORMATS

Kick-off retreat, ideally in conjunction with Module 2

2 START A RESEARCH PROJECT

| Overview of the TIL and the research topic from a transformative research perspective

CONTENT

Students deepen their understanding of the **ideal-typical course of a transformative research project**. It can be helpful to have inputs (ideally from pioneers) on good practice examples from the field of transformative, innovative research, providing specific detail from within the projects and describing processes, problems and lessons learned.

The knowledge gained regarding the ideal-typical process will then be **transferred to the individual project context in the TIL**. For this purpose, the formal, organisational and timing arrangements for the TIL are clarified along with those of the individual research project.

Students also start to set out their rough ideas **for their own research topics**. Exchange within the group offers new ideas and can also enable project teams and also tandems to be formed for peer learning. It is important here that students keep in mind both the idea of sustainability and that of transformative research: The point of departure should be a real-world, sustainability-related problem or a need for change that also includes an academic component and an as-yet unresolved issue. In addition, students should be encouraged to develop projects that are feasible for them, meaning projects that are ideally small in scale and also manageable in terms of time and space.

Narrowing down the topic to arrive at a specific research gap is done individually by the students and includes a systemic perspective on real-world possibilities for action and the problems faced as well as the need for change and for research into the relevant scientific knowledge base.

LEARNING OBJECTIVES

- **Understand ideal-typical course of a transformative research project and transfer it to the individual research and teaching context during the TIL**; be familiar with the necessary formalities, examination requirements, etc.
- Decide on the research topic and, with additional research, increasingly narrow it down to a (rough) research gap. See this as the groundwork from which the actual research question is developed jointly with a practitioner partner.
- **Focal competencies**: Systems thinking, anticipatory competence, normative competence, preventative self-care (e.g. being able to properly assess project feasibility), continuous learning and, where applicable, communication and teamwork skills.

OPTIONS FOR ACADEMIC IMPLEMENTATION

- **Clearly communicate and visualise the TIL framework** (timeline, formalities, expectations).

- In a *fast-forward session*, deepen understanding of the ideal-typical course of a transformative research project. Working in small groups, students go through the steps of the process hypothetically in a matter of minutes. Each step starts with a baseline question that is followed by a brainstorming session on the largest-scale and the smallest-scale options for project implementation and selection of a research idea for further development. Guiding questions for each of the steps include: What do you think needs to be changed? What does this field of research involve? What practitioners might be interested in working on it? What would you implement in collaboration with one of those practitioners to bring about change? What would you conclude from the research when the process is complete? The fast-forward session can focus on research ideas already identified, but can also look at freely invented or even deliberately hypothetical and unrealistic projects. It can also generate new project ideas. Students can play with their

research idea to work out 'maximum-scale' and/or 'minimum-scale' projects for implementation. This offers broad scope in which to explore various options.
- Based on the outcome of the fast-forward session and the general conditions of the TIL, **have students set out a first, rough schedule for the research project** to ensure they develop a sense of their own resources and possibilities and keep an eye on things like vacations, public holidays, examinations, etc.
- Encourage **students to take their personal interest as a starting point** in identifying their research topic as this increases their motivation to implement the project.
- As a first step in finding a topic, students can **take dialogue walks in tandems** to exchange their visions and views on the need for change, clarify their key interests and see them mirrored.
- So as to **not lose sight of the real-world problems and the research interest**, thought experiments can be conducted as early as in the topic-finding stage to assess the specific problems faced by actors and how a potential solution might be made visible/measurable.
- Encourage **peer-learning arrangements**, such as student tandems that serve as sparring partners in the search for their research topic. Group exchange is also a useful tool, for example to obtain additional references to specialist literature and suggestions for individual research.

RECOMMENDED FORMATS

Kick-off retreat, ideally linked to Module 1; individual work phases and peer-learning formats

3 JOIN FORCES WITH PRACTITIONERS

Find practitioner partners, develop joint research question, agree on project and roles

CONTENT

This module focuses on the **co-design phase and thus on the start of collaboration with practitioner partners** and joint specification of the research question and the research project.

Starting from their chosen rough research gap, **students systematically identify relevant stakeholders and actors** and locate potential practitioner partners for their projects. Suitable methods for this purpose include system mapping, problem mapping and stakeholder analysis.

In addition, students are prepared for **collaboration with practitioner partners during the co-design phase**. This includes:

- Looking at the potential roles of transformative researchers, e.g. reflexive scientist, knowledge broker, facilitator, change agent and self-reflective scientist (Wittmayer & Schäpke, 2014). Emphasise the fact that it can be something of a challenge to avoid both a one-sided service delivery role for practitioners and the traditional role of the aloof academic for researchers.
- Teaching good stakeholder engagement practices with a view to the co-design phase. Providing good-practice examples is useful, as is asking students to share any previous experience with collaboration.
- Provide inputs on vision and backcasting approaches, and on moderation and discussion formats for collaboration with practitioner partners, including for how to address them, meeting them, project scoping (including goal-setting) and co-leadership, agreeing roles and responsibilities, project planning.
- Outline the key prerequisites for collaboration (such as personal readiness to enter into discussions, general openness on the part of practitioner partners regarding transformative research, contact persons with decision-making authority regarding a project).
- Encourage students to make a start and lower their inhibitions regarding contact initiation.

Contact with practitioner partners is initiated by the students themselves or by project teams. **The same applies to starting joint development of specific research questions and project planning (co-design)**. It is important to clarify with practitioner partners at an early stage the criteria to be used in evaluating the impact of the real-world lab experiments. It is recommended that prior to commencing an intervention, an analysis be conducted on the real-world starting point/baseline (e.g. system model, relationships and certain benchmarks such as traffic flows, sales figures, existing narratives). Agreement should also be reached on how and by what yardstick to measure the changes resulting from the intervention.

In the search for potential practitioner partners, students help each other by providing ideas and contacts. Having contacted potential practitioner partners, they then enter into open-ended discussions in which the two sides sound out their respective interests and questions and agree to collaborate if they find a match.

LEARNING OBJECTIVES

- **Be aware of and apply methodological and theoretical knowledge** on transdisciplinary and transformative research practice with a focus on co-design (e.g. problem mapping, stakeholder analysis, vision development and backcasting).
- **Be aware of and apply stakeholder engagement methods**, e.g. dialogue formats and project planning approaches (agreeing structures, interests, roles; joint presentation of problems).
- **Reflect** on challenges and opportunities in the project development phase and on students' potential roles in the research process, also in terms of personal abilities and skills, ambition and motivation.
- **Specification of the research project and formation of the project team**, i.e. find practitioner partners, develop a joint research question and initiate joint project planning.
- **Draft a benchline analysis** as a reference system for evaluation following the real-world experiment.
- **Focal competencies**: Stakeholder engagement, responsive project management, strategic competence, systems thinking, anticipatory competence, normative competence, interpersonal competence, communication and teamwork skills, continuous learning, preventative self-care (in dealing with one's own role).

OPTIONS FOR ACADEMIC IMPLEMENTATION

- **Present methodological approaches** (problem mapping, stakeholder analysis, vision development and backcasting) **and have them tested in an exercise as part of the research project.** Students are not always expected to complete the entire exercise. The focus is placed on trying out the methodologies and clarifying possible questions concerning them. Students are invited to take these initial findings and develop them further on their own.
- To boost students' confidence when contacting project partners, it can be helpful to provide **inputs from practical examples** (actor relationships, how they came about, potential problems and lessons learned). It can also be helpful to arrange a **'live discussion'** in which a practitioner partner and the respective student discuss their questions and their project scope in the form of a podium discussion, perhaps with a lecturer serving as moderator.
- **Lower students' inhibitions and help them reflect on the feasibility of their project**, i.e. by encouraging them to look for topics that offer scope for action and for which stakeholder relations and contacts already exist (e.g. neighbourhoods, communities, small organisations, businesses, associations, networks).
- **Roleplay** is useful in fostering an understanding of and reflecting on potential role assignments by enabling students to adopt different views (practitioner partner, researcher, administrative staff member) and to play out their own potential roles (researcher, service provider, change agent, etc.) in order to subsequently reflect on this experience.
- Have students keep a **research diary** to ensure ongoing documentation which can be especially useful for subsequent evaluation (report or final exam/thesis) and to help them reflect on what they have learned.
- It is important to plan an adequate period of time in which to **form project teams** comprising students and practitioner partners.

RECOMMENDED FORMATS

Exchange sessions (both presence and online), individual project work with ongoing, closely monitored peer learning and regular tutoring as needed.

4 PLAN AND CONDUCT REAL-WORLD EXPERIMENT(S)

Developing and implementing real-world experiments with practitioner partners

CONTENT

This module focuses on the **development and implementation of the real-world experiments or interventions**. Using theory and examples from practice, students deepen their knowledge on real-world experiments and interventions. Field studies in real-world labs are useful for this purpose.

Teach or remind students of **methodologies for use in developing intervention approaches** which can help them in brainstorming sessions with their practitioner partners – such as problem and system mapping, brainstorming techniques and design thinking. These methodologies can be applied as a group to try them out and develop initial ideas.

The **development of a research design for the planned intervention/real-world experiments** is also addressed. This includes looking at (science) ethics questions, e.g. the relationship between the depth of an intervention in a real-world experiment and participants' assumption of responsibility. In addition to its implementation it is important to think about documenting the intervention at an early stage so that the results are available for academic use (e.g. in a Master's thesis). Methodologies for use in securing and interpreting transdisciplinary research outcomes are also addressed.

A key focus in this phase is on **opportunities for reflection and inputs for preventative self-care**. It is important that students develop feasible projects and are not over-ambitious. It is also important for students to reflect again on the assigned roles (also in terms of the methodological procedure, such as observing/intervening) and on the need for tailored support (e.g. from educators or in peer learning), both in project management and in preventative self-care (e.g. dealing with stress/emotional coping techniques). At this point, it makes sense to review the learning process so far and, with this in mind, to encourage students to take the plunge and implement a project despite the unknowns.

Both **development and implementation of interventions** are performed by students in collaboration with their practitioner partners.

LEARNING OBJECTIVES

- **Subject-matter knowledge** regarding real-world experiments and interventions (definition of concepts, practical examples, procedures and approaches in co-design) and the associated ethical concerns in the research process.
- **Have knowledge of and apply methodologies** for use in developing, implementing, securing and evaluating the results of interventions/real-world experiments.
- **Conducting the co-design phase**, i.e. designing a research question and the corresponding real-world experiments/interventions in collaboration with practitioner partners.
- **Reflect on the process so far**, in terms of, among other things, the learning experience and especially the ongoing clarification of roles, and a greater understanding of one's own needs and abilities in terms of preventative self-care.
- **Focal skills**: Systems thinking, strategic competence, interpersonal competence, communication skills, teamwork skills, continuous learning, responsive project management, stakeholder engagement.

OPTIONS FOR ACADEMIC IMPLEMENTATION

- **Schedule individual work phases as a group** to provide opportunity for sparring with educators and fellow-students.
- **Excursions to existing real-world laboratories and exchange with TIL graduates** to familiarise students with concrete examples of interventions, how they came about and how they were implemented.
- **Suggest methodologies for use in developing interventions and test them in a protected environment** so that students can apply them with their practitioner partners at a later date.
- Because students mainly tend to focus on the practical level, when planning interventions it must be ensured that they also think about the project's **scientific use** (e.g. what is to be measured and how). Is it possible to conduct a before-and-after survey to estimate the impact of the experiment? Perhaps conduct an additional fast-forward session on this point (see Module 2).
- **Input and exercises for self-assessment and preventative self-care**, such as emotional coping techniques. It is absolutely essential that students be encouraged to develop and implement interventions that are feasible for them. It helps here for students to think of their project, in the protected sphere of the group, in terms of the maximum-scale and minimum-scale intervention and to reflect on preconditions and feasibility in each case.

RECOMMENDED FORMATS

Exchange sessions, both in-person and online (perhaps beyond the first TIL semester), a reflection seminar (as appropriate), individual project work with ongoing, closely mentored peer learning and regular tutoring as needed.

CONTENT

5 EVALUATE THE RESULTS | Reflection and evaluation of the implementation process and transfer of the results to students' own research work

This module concludes the project work and the TIL. The main activity involves the **evaluation of the research results by students in collaboration with their project partners**. It is important that the students know (building on the research design developed) what they want to evaluate and how they want to go about it with their practitioner partners. This includes the following key components:

• Methodologies for use in joint interpretation. For example, a renewed presentation of the initial system or model showing altered influences, figures, etc., as well as the feedback effect from the initial system analysis and the original objectives can be useful in order to jointly evaluate the process and the interim and final outcomes of the real-world experiment. Also, looking at the *most significant change* (brief individual descriptions of key changes and participatory evaluations of them by all involved) is helpful in order to document the impact of the interventions.
• (Moderation and presentation) techniques to find suitable ways to present and prepare data and results, both for practical purposes (presentations, talks, guidelines, informal informational material, prototypes, etc.) and for academic use (publication of books and articles, linking to literature, etc.).
• Become familiar with/identify methodologies for joint process review, such as the *storywall* method (jointly completed timeline with milestones).

In this phase of the project, it may be necessary to offer the group additional resources and give students methodological support in securing and interpreting transdisciplinary research results. In mentoring, the main focus is placed on **sensitising students to the need for research outcomes to provide added value for practitioners and for further research**.

Students should also receive help in transferring their **research projects into their thesis**, usually based on the research results and possibly also related to meta-level reflections on transformative research.

Completion of the research project constitutes completion of the TIL and is thus an important moment in a shared, group dynamic. This should be marked with concluding presentations and a joint celebration as a group. It should also be linked up with exchange among participating students and networking with practitioner partners, the next TIL cohort and the transformative research community. A final group reflection session can be helpful at this stage.

LEARNING OBJECTIVES

• **In performing co-evaluation**, apply methodologies for transdisciplinary documentation and interpretation of outcomes.
• **Awareness** of both the practical and the scientific added value to be gained from research results.
• **Presenting research results**.
• **Reflect** on personal learning experiences.
• **Competencies**: Systems thinking, normative competence, interpersonal competence, communication skills, teamwork skills, continuous learning, responsive project management, stakeholder engagement.

OPTIONS FOR ACADEMIC IMPLEMENTATION

• **Where needed, offer additional methodologies**, again in a mix of input and trial and error in a protected sphere; joint interpretation and evaluation as preparation and/or follow-up for the co-evaluation can also be supportive.
• **Assist the transfer of results to a thesis**, for example in drop-in office hours. Ensure familiarity with formalities and any differing rules for experimentally designed theses (perhaps in groups). Having students write exposés and then discussing them as a group can also be useful.
• **Provide space for reflection, both for individuals and as a group**, perhaps address personal difficulties and focus on the associated lessons learned. Such reflection needs a protected sphere which is provided around the time of but separate from a final or closing event.
• **Create space for a final gathering as a group**, perhaps a celebratory presentation of attendance certificates and memory boxes (group photo, etc.).
• **Use a final project presentation as a networking opportunity**, e.g. by inviting practitioner partners, interested members of the public, the research community and policymakers.

RECOMMENDED FORMATS

Possible additional exchange sessions in the second semester, perhaps a second reflection seminar, a concluding seminar, parallel peer learning and tutoring formats (and general offers of mentoring for theses).

CONTENT

6 CONCLUDING SEMINAR | 7 MASTER'S THESIS

The way the TIL is completed varies according to the course of study and personal decisions. The above sets out an ideal-typical process and for many students already took a different turn in the pilots. Both the pilots and the overall experience with real-world lab projects show that they are both time and resource-intensive to implement. Whether a TIL ends with a regular seminar paper and reflection, or with a full-blown Master's thesis is left to students' discretion and is in no way required. Depending on how students decide, implementation can vary considerably in time and resource intensity.

4. THINGS TO WATCH: TIPS AND TRICKS FOR TIL IMPLEMENTATION AND COMPLETION

4.1 How can a transformative innovation lab be integrated into a study programme?

The following is the result of practical experience gained when implementing and completing the TIL.

Given that it is rarely possible for university structures such as curricula and examination regulations to be reorganised at short notice, it is recommended that the following aspects be taken into account:

Implementing a TIL in suitable existing current study programme modules
First of all, a check should be made as to which modules of a study programme are suitable for integrating a TIL, in terms of both content and structure, and have suitable examination formats. The teaching units for the sequential modules in a study programme are set out in the programme's module handbook. The modules take in thematic sub-areas packaged in the form of lectures, seminars and other formats. The examination regulations lay down the conditions and guidance on the examination requirements within a module.

At Leuphana University Lüneburg:
The Master's Forum and Research Perspectives module in the Sustainability Science Master's programme has proven to be a suitable format in which to integrate the TIL. Its aim is to support students in developing research proposals and teach key methodologies used in sustainability science. TIL participants received the five credit points for completing the module.

Selection of a suitable module is closely linked with the associated examination requirements. The TIL can be easily combined with a wide range of examination requirements. Presentations, essays, portfolios (practice) reports and oral exams have proven especially suitable. Combined assignments are also recommended: The examination can take the form of a speed talk presentation or a presentation combined with a subsequent concluding report. These usually meet the national requirements laid down in examination regulations. Written exams are less well-suited as the focus is on practical experience. Experience has shown that project-based seminars, hands-on formats and Master's formats can easily be combined with a TIL. This is due to the fact that the number of students that can participate in a TIL cohort is limited

because of the need for mentors. The duration of the underlying module must also be taken into account. Ideally, it will run over two semesters and allow enough space for co-production and co-evaluation. If a module only runs over one semester that ends with an assessed item, the Master's thesis follow after that module.

At Freie Universität Berlin:
In the Futures Studies Master's programme, the project internship in Module 8 was an ideal candidate for the TIL. It serves the development of research questions and potential solutions for selected objects in practice and aims at the acquisition of practical abilities and skills. TIL participants received the corresponding 15 credit points for their active participation and were able to complete the module by writing an experience report.

Keeping an eye on semester schedules and semester timetables
During the TIL design and piloting phase, it was shown that it makes sense to integrate the TIL into the third and fourth semesters of a Master's degree programme. Content from the first two Master's semesters can be further explored according to individual needs or be used to embed the subject matter in preparation for the lab. In the third semester, the lab prepares students to work on an experimentally designed Master's thesis in the fourth semester where that is provided for as a goal. The examinable component can be credited towards the final exam. Here, it is important to ensure that lab implementation neither disrupts the ideal-typical study process nor prevents the study programme from being completed within the standard period of study.

Semester timetables provide useful guidance when it comes to seeing which days are suited to slotting in lab activities and thus prevent collisions with university events or other course commitments (e.g. administrative conference days or timetabling for advanced-level/complementary subjects). Block seminars over several days have shown to be extremely useful in implementing the TILs, for example in the form of kick-off retreats to provide more intensive induction and allow students to get to know and talk with one another (particularly when students from different universities and/or study programmes are participating). When planning these kinds of block seminars, it must be remembered that they should not use up the number of hours earmarked for the module as a whole.

At Leuphana University Lüneburg/ Freie Universität Berlin:
The TIL was implemented with a four-day kick-off event, two two-day seminars, one full-day seminar and two blended learning sessions. In addition to presence events, enough time was also planned-in for individual project work (see Section 3.1).

Study programme selection
There are basically no limits when selecting a suitable study programme in which to implement at TIL. There are, however, some points of reference that can be of help.

It should be a study programme whose content is linked to or already addresses sustainable development goals and paths and the role that research plays in change processes. It should also focus on applied, developed and practice-related research. A basic repertoire of research methodologies is essential (e.g. conducting interviews, developing survey questionnaires, focus group techniques, natural science and social science modelling, scenario development) which students can use in their research projects and in research planning and evaluation. To grade the Master's thesis and examinable components, sufficient basic knowledge of experimental approaches of this type is needed on the part of the educators.

Determine a manageable group size for participation in the TIL
Implementing the TIL requires intensive mentoring of students for the duration of their transformative research projects. It takes time to answer individual questions, for reflection and exchange, to plan possible excursions and to work on exposés and reports. The teaching role thus calls for far more than specialist expertise. To provide adequate support, the recommended maximum group of students per teacher is 10 to 15, but can be adjusted in line with the envisaged examinable component and teaching plans. With team teaching, the number of participants can be increased. If a Master's thesis is chosen as the final outcome, then the group must be smaller.

At Leuphana University Lüneburg/ Freie Universität Berlin:
The number of participants per study programme and cohort was limited to ten.

Start early when planning a TIL

When planning a TIL, it is advisable to start early (at least one-and-a-half semesters in advance) because universities vary greatly in terms of flexibility with regard to formal and informal requirements. Key decision-making criteria for curriculum planning by study commissions or faculty councils include financing, seminar implementation planning, the fit with existing requirements in examination and study regulations, ensuring that the study programme can be completed within the standard period of study and adequate student mentoring. The necessary lead times vary significantly. Accordingly, the university-specific conditions for promising implementation of a TIL should be identified at an early stage and planning conducted accordingly.

Find suitable contact partners and collaborators and join various networks

It can make sense to find out who in the Dean's office can help in the design of a seminar and a module for the TIL. This can vary depending on the university concerned. Some universities have a teaching service or support provided by educationalists. Where educators show an interest in implementing a study module as part of a TIL, it is advisable to contact the person responsible for the module itself. And it makes sense to take decision-makers on board who are open to the idea of a TIL. Formal applications are usually submitted to the Dean's office. The examinations office is not yet involved in the design phase, but is an important touch point with regard to exam regulations.

The TIL aims to implement a transdisciplinary transformative research project, focusing on collaboration with practitioners and the joint development of experimental collaborative projects. University-based research projects involving practitioners and local stakeholders on the basis of their contacts with existing networks provide a good infrastructure that should not go unused. In this way, additional resources can be utilised and practical projects can be academically supported and evaluated – a good starting point for the university, the students and the practitioner partners.

> **At Leuphana University Lüneburg:**
> This worked well here thanks to proximity to the Lüneburg 2030+ project, in which citizens, the local authority and the university develop visions for Lüneburg in a participatory approach and implement them in real-world experiments. Students were able to freely decide to connect their own research to Lüneburg 2030+'s ongoing collaborative process.

Advertising the TIL programme and its selection process

To recruit interested and motivated students, it makes sense to advertise the programme. It is advisable to plan a lead time of at least one semester. The format should be advertised in the lectures held during the semester prior to the one in which the TIL is planned. Various communication channels can be used depending on the respective target group: Notice board, newsletter, e-mails, the university website, presentations at events (e.g. lectures, seminars) or a dedicated informational event.

It makes sense to combine participation in the TIL with an application process that allows students to submit an (informal) motivation letter. This simplifies lab planning because it enables an assessment to be made of students' interests, their prior knowledge and their expectations. And on that basis, a selection can be made should expressions of interest exceed the maximum number of places.

> "Sharing ideas as equal partners and a great atmosphere. I learned a lot. It was a really nice and interesting experience. It was one of my favourite seminars, and probably the one where I learned most because of its practical relevance and the opportunity to try things out first-hand and also reflect on them throughout the seminar. Thank you." (TIL participant, 2020)

4.2 Tips and tricks for TIL implementation: take-aways from events

In the following, specific tips are given on how to implement a TIL based on the experience gained with the two TIL cohorts and the feedback received from participants.

Create a common knowledge base

At the beginning of the lab, theoretical inputs on transformative sustainability research and on the ideal-typical course of a real-world lab are absolutely essential (see Section 2.1, 3.1 and 3.3). The information in the section on transformative research and academic implementation can be used in planning and teaching the theoretical input. Inputs from experts, both researchers and practitioners, round off the teaching programme.

Students find the illustration of theoretical input by means of reports on practical experiences and exchange with practitioner partners particularly enriching. Excursions, for example as visits to local real-world lab projects, serve as sources of inspiration and in gathering project ideas. And in many cases, they foster an inspiring change of perspective. Students also find it especially helpful if the content of what they have learned is discussed and integrated into the Transformative Innovation Lab.

Intersection between two study programmes

As described in Section 3, there are advantages in linking different study programmes in the form of collaboration and exchange. When taking this approach, at the start of the TIL enough space should be given for the topic to be introduced and to establish a pleasant atmosphere so students from both study programmes can to get to know one another. Developing a common understanding of specialist terms and methodologies is time-intensive. In preparing the lab, introductory literature can be provided in advance and more general thematic inputs can be offered in the initial sessions. Room should also be provided to exchange ideas on overlaps and differences, methodologies, standpoints and the challenges involved in the two study programmes. This is where in addition to in-person events, it is useful to have an online platform for a student forum and to share literature. And in fostering collaboration, it has also proven useful to highlight the potential of the academic and methodological perspectives of the other study programme or to work together to identify them.

Peer learning for more give and take

Peer learning (across different study programmes) can help students exchange views and ideas as equal partners, provide one another with mutual support and engage in constructive critique. They remain among themselves and can be more open when addressing any difficulties or uncertainties they may have. Although the use of peer learning in the TIL was readily welcomed, its implementation is by no means a given. In many cases, students' focus and pace differ to such an extent that it is not always possible to achieve regular, fruitful exchange that is perceived as being helpful. Yet others benefit greatly from regular sparring and mirroring with a counterpart. It is advisable to have teams form on a voluntary basis and/or to allow team constellations to be changed as part of the process.

> "Gaining insights into another study programme helped me consolidate my own views. And the exchange with *like-minded people* was enriching and inspiring." (TIL participant, 2020)

CONCLUSION AND OUTLOOK /|||||||

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5. CONCLUSION AND OUTLOOK

It is hoped that this handbook and the online materials provided will make a useful and effective contribution to embedding the teaching of transdisciplinary and transformative research more firmly in higher education. Achieving the sustainable development goals – while avoiding solutionism, overreach and quick fixes – calls for reflective and responsible applied research formats. As these are methodologically and ethically demanding in their application, it is all the more important to provide prudent and broad-based mentoring for learning processes. Implementing a TIL calls for courage, flexibility and an abundance of staying power. But despite the obstacles and in the spirit of experimentation, we encourage you to start out with pilot projects and trial modules and in doing so to generate valuable experiences and ideas for improvement. In implementing this funded project we had the great opportunity to accompany students in their research processes and projects over a period of two years and are grateful for the many insights and learning experiences gained as a result.

Like every project, the TIL has been subject to a range of limitations and a number of issues have arisen that need to be addressed in more detail going forward. These include, for example, academically coherent integration of additional study programmes and empirically sound measurement of students' skills development over the course of the TIL. It is also important to analyse the success factors in and the obstacles to researcher-practitioner collaboration and gain a more differentiated view of their differing roles. Also in its infancy is the retrospective assessment of how such real-world labs impact and affect personal development, the scientific debate and the promotion of sustainable practices. Formats for transdisciplinary and transformative research and teaching must prove their value on all three counts.

We look forward to receiving further suggestions and to a lively debate on the further development of teaching and learning opportunities to train sustainability change agents who will pave the way to a sustainable world.

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Nele Fischer studied media sciences and futures studies and works as a freelancer and researcher. She works among other things on the creative freedom that can be gained by reflecting on futures. Working on the TIL team for Freie Universität Berlin, she is fascinated by the intensive reflection and change processes initiated during the TIL.

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