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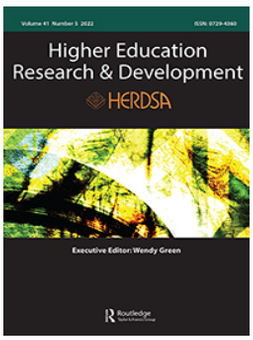

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Models of transdisciplinary knowledge production at universities: a Romanian case study

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ABSTRACT

The main objective of this study is to better understand the challenges of transdisciplinary knowledge production processes and its institutionalisation at universities. Transdisciplinary research is considered a collaborative and integrative praxis grounded in different ways of knowing, acting and being. However, transdisciplinary research practices differ significantly in the relations between institutions and actors. These differences have an impact on how transdisciplinarity is institutionalised. There is a need to incorporate them into a larger framework of ongoing transformations of scientific timescales and spaces at universities. We present the results of a case study developed at Babes-Bolyai University (Romania). We discuss it against the background of three models of transdisciplinary knowledge production and two approaches of transdisciplinary problem-solving research. We apply a qualitative methodology of micro level analysis that explores research practices and their embeddedness in the institutional environment. We analyse conditions that enable transdisciplinary knowledge production and show how transdisciplinary institutionalisation can be better understood using the proposed framework applied to the case study. It could be shown that taking into consideration the differences in the models of transdisciplinary knowledge production proved to be useful to gain a deeper understanding of processes of institutionalising transdisciplinarity at universities.

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Transdisciplinarity; knowledge production; institutionalisation; Romanian university; case study

Introduction

Transdisciplinary research has emerged as a response to the growing pressure on science to deliver faster and more tangible results and benefits for society (Gibbons & Nowotny, 2001). Significant contributions have been made in multiple fields, ranging from science and technology studies, environmental and sustainability sciences, health and biomedical sciences, urban studies, development studies, feminist theories and gender studies to media studies and philosophy, among others (e.g., Aeberhard & Rist, 2009; Balibar,

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2015; Bernstein, 2015; Jasanoff, 2010; Klein et al., 2001; Lang et al., 2012; Novy et al., 2012; Osborne, 2015; Ramadier, 2004; Stokols, 2014; Van Breda & Swilling, 2019) where urgent needs for transformation are driving the search for a novel form of problem-oriented, transformative research. Transdisciplinary research is considered a collaborative and integrative praxis grounded in different ways of knowing, acting and being (Vilsmaier et al., 2017). However, there are multiple understandings of transdisciplinarity (TD) that emphasise different dimensions of the changing relations between science and society (Bernstein, 2015; Klein, 2004, 2014). Research practices that are labelled as transdisciplinary differ significantly with regards to the type and quality of relations between different institutions and actors. These practices are shaped by a multitude of historical, political, cultural and societal elements that change over time (Mobjörk, 2010), having an impact on how transdisciplinary research is institutionalised at universities. In order to better understand and advance the institutionalisation of TD, there is thus a need to take these differences into account.

We propose to incorporate transdisciplinary knowledge production processes into a larger framework of ongoing transformations of scientific timescales and spaces (Felt, 2017) among universities, science and society (Nowotny, 2017). We approach TD as a knowledge regime (Felt et al., 2013) and study the multiple dimensions where transformations of timescales and spaces (Blackley et al., 2020) become manifested.

The main objective of this study is to better understand the challenges of transdisciplinary knowledge production processes and its institutionalisation at universities. In this article, we present the results of the case study of Babes-Bolyai University (UBB) in Romania and discuss the results against the background of current discourses on TD and of previous studies where we identified two iterative levels of institutionalising TD within universities as a policy and a practice (Vienni Baptista et al., 2018; Vienni Baptista & Rojas, 2019). We apply a qualitative methodology of micro level analysis to investigate researchers' practices which allows us to address the broader imaginaries and values present in the transdisciplinary regime of knowledge production (Felt et al., 2016), and to reflect on the process of institutionalisation of TD and how this influences researchers' practices and vice versa.

We aim at answering the following questions: (i) What are the conditions that enable transdisciplinary knowledge production at UBB? And as a corollary, what is the role of researchers in such process and how do they interact with social actors? And (ii) How to study the different types of transdisciplinary knowledge production at universities taking into consideration that these differences play a significant role with regards to institutionalisation processes?

To answer these questions, we analyse types of practices performed by researchers and systematise them according to three models of science–society relations built by Felt et al. (2016). There are three ways in which researchers and societal actors inhabit the knowledge space where TD is produced, namely: (i) the linear translation model; (ii) the delimited neutral arena model; and (iii) the temporary shared epistemic arena model.

The article is organised as follows: first, we present the concept of TD and the related literature and rationale. After elaborating on our methodology, we introduce the Babes-Bolyai University and the reasons for its selection as a case study. Then we present the data analysis to show how TD is performed at this university. We discuss the dimensions

in the light of the rationale we propose. Lastly, we draw conclusions that build on the results of this study and open lines for future research.

Related literature and rationale

The discourse on TD has become manifold and widespread. It complements and partially overlaps with the discourse on interdisciplinarity which is generally applied to integrative research among different disciplines or bodies of specialised fields of knowledge (National Academy of Sciences, 2005). To systematise this heterogeneity, Klein (2014) analysed the discourse and identified three major discourse streams: (i) a discourse of 'transcendence' that aims at unity of knowledge, transcending the narrowness of disciplinary worldviews and practices; (ii) a discourse of 'transgression' that emerged out of a fundamental critique of the system of knowledge and education, and that relates to discourses on democratisation of knowledge; and (iii) a discourse of 'problem solving' that aims at tackling complex problems and transforming concrete situations in collaboration with representatives of diverse societal institutions and citizens (e.g., OECD, 2020).

Klein notes that underlying these three discourse strands is a growing concern about the science–society interface and innovative methods and processes for knowledge production that are relevant to societal challenges (Klein, 2004, 2014; Lawrence, 2015). The three show certain overlaps. Conversely, there are also significant divides, in particular within the third strand, named as problem solving TD (Klein, 2014), the one we are emphasising in our research. Such transdisciplinary approaches have been developed in the field of environmental and sustainability science, health science and development studies, among others, over the last three decades (e.g., Aeberhard & Rist, 2009; Lang et al., 2012; Novy et al., 2012; Van Breda & Swilling, 2019; Vilsmaier, 2021). They deal with types of problems that are considered to be societally relevant and pressing, and that call for transformation. This type of TD is characterised by: (i) inter-sectoral collaborations; (ii) context sensitivity; and (iii) aiming at both understanding and acting for transformation.

In order to tackle societal problems, teams of researchers of different disciplines and trans-sector collaboration with societal actors related to the issues of concern are realised in order to improve understanding and enable transformation through different roles in relation to the problem. Such collaborations can imply knowledge transfer (Knaggård et al., 2019), consultation or mutual learning (Riedy et al., 2018) in participatory and decision-making or governance processes (Aeberhard & Rist, 2009; Akpo et al., 2015; Mielke et al., 2016; Novy et al., 2012; Roux et al., 2006).

However, these transdisciplinary endeavours differ significantly with respect to the role and status of scientific and societal actors, the type and quality of relations, and represent different modes of knowledge production. The main differences consist of the valuation of knowledge production and the power over the design and implementation processes (Fritz & Meinherz, 2020; Vilsmaier et al., 2017). Despite transdisciplinary researchers seeking to overcome the techno-scientific domination in knowledge co-production, social and epistemic control often remains with the scientists (Herberg & Vilsmaier, 2020).

To contribute to this discussion, we consider that the role and status of scientific and societal actors result in two different approaches of problem solving TD: (i) additive or (ii) entangled (Vilsmaier, 2021). The additive approach considers collaboration with societal actors as an additional benefit for the research process. It separates scientific practices from non-scientific practices and in so doing reproduces a modern dichotomy that is based on autonomy of science. This autonomy is reflected in its methodology and in its role in society: inhabiting a sphere that is considered to lie beyond the political (Latour, 1987). In additive approaches, commonality is constituted by the issue of concern, and responsibilities of each of the actors involved are clearly divided according to their societal role. The 'co' of co-production and co-design, often stressed to describe transdisciplinary research, relates to inter-personal or inter-sectoral collaboration.

Entangled approaches have a far deeper understanding of a co-production in terms of worldmaking (Jasanoff, 2010). It is oriented towards transformation through a research practice that is characterised by different ways of knowing, acting and being in the world. All actors involved are considered to actively contribute to research with different modes of knowledge production (being either based in every-day life, a professional practice or scientific research) and different roles in the research process, while power is shared by all participants and no way of knowing, acting and being is privileged (Rivera Silva et al., 2018). Entangled approaches constitute in-between research spaces that are grounded in difference while pursuing a shared aim that guides integration (Vilsmaier et al., 2017).

For the formation and development of transdisciplinary knowledge regimes and their institutional incorporation and manifestation in research cultures and communities at universities, it makes a significant difference whether an additive or entangled approach to TD is pursued. While an additive approach requires communication and collaboration structures, but does not necessarily tackle institutional and epistemic logics, an entangled approach calls for changes in the logic and landscape of institutions and a reframing of values of different practices of knowledge production, and ultimately of the concept of research (Appadurai, 2006; Vilsmaier et al., 2017).

Felt et al. (2016) take a closer look at the different imaginaries of science-society relationships that are performed by research participants and reflect on how they frame the potential knowledge relations developed in transdisciplinary research projects. The authors show how, why, where, and when efforts to redraw the boundaries between the scientific and societal realms are made. By investigating these moments and practices in transdisciplinary research, they obtain a deeper understanding of the challenges of this type of research, of the different roles that scientific and societal actors perform, and identify what is needed for this approach to knowledge generation to be successfully practised. Further, processes of TD institutionalisation need to be analysed on two iterative levels: (i) as a policy, and (ii) as a practice (Vienni Baptista et al., 2020; Vienni Baptista & Rojas, 2019). TD is a policy when a university decides to implement it as part of academic programmes, research initiatives, and overall educational activities by initiating a set of actions as reforms, plans, or guidelines. However, establishing a transdisciplinary policy does not guarantee reaching its objective or implementing the actions it prescribes. Therefore, we also understand TD as a practice, i.e., activities that bring policy and associated forms of transdisciplinary knowledge production to life.

To gain a more profound understanding of the complex dynamics at work concerning TD, careful investigation of the concrete intertwinements of imaginations, expectations, structures (institutions, programmes, careers, etc.), people, and values is needed (Felt et al., 2016).

The notion of regime refers to the heterogeneous assemblages of three components (adapted from Felt et al., 2016, p. 5): (i) ideologies and myths guiding transdisciplinary knowledge production, jointly with the accompanying prescriptions for producing and validating knowledge; (ii) institutions and their institutional logics, i.e., shared beliefs and practices, broader imaginaries and values embedded in knowledge generation; and (iii) researchers, extra-scientific research partners and the actors who govern the research (Table 1).

Methodology

In this study, we examine the micro level of research practices at the Babes-Bolyai University in Romania. The selection of UBB as a case study (Yin, 2014) consisted of the analysis of a unique social unit. The case study approach is used to generate an in-depth, multifaceted understanding of a complex issue in its real-life context such as transdisciplinary research practices and their embeddedness into an institutional environment (Yin, 2014). Our aim is to offer a thick description (Geertz, 1988) of lived realities.

Data collection and analysis

Yin (2014) recommends the use of two different data sources and compliance with the principle of triangulation (Flick, 2007) to ensure the internal validity of the research. We combine two different data collection techniques:

Table 1. Models characterising the relationships between scientific and societal actors in knowledge production processes (based on Felt et al., 2016).

Characteristics	MODEL 1 Linear Translation Model	MODEL 2 Delimited Neutral Arena Model	MODEL 3 Shared Epistemic Arena Model
Problem definition	Societal concerns/ problems are pre-existing and 'out there'.	Societal actors have experiential knowledge and a better understanding of the problem. Scientific and societal actors co-defined a specific goal.	Joint reflections on the research topic are essential to increase scientists' understanding of complex problems.
Research arena	Situated in two ends of a spectrum: knowledge producers and knowledge consumers.	'Neutral' arenas of interaction in specific moments but still situated in two ends of a spectrum: knowledge producers and knowledge consumers.	Coexistence of actors from different arenas in a shared, common and temporary collaboration space.
Relationship between societal and scientific actors	Scientific and social arenas are separated	Mutual engagement at specific moments between societal and scientific actors.	Mutual learning processes. Shared epistemic territory is built.
Scientific Actors	Very powerful	Gatekeepers of their respective territories.	These are able to interpret the extra-scientific actors' knowledge.
Societal actors	In need of scientific explanations/ information	Strongly related to the problem.	Knowledgeable agents.
Knowledge	Produced by scientific actors and then is translated to society.	Knowledge transfer.	Co-production of answers according to societal actors' needs.

- Systematic literature review on TD (Jahan et al., 2016): This review allows us to identify practices offering opportunities, key elements of practice and other overarching issues developed at institutions to foster TD.
- Semi-structured interviews (Flick, 2013): Twelve interviews were conducted with representatives of research projects. We had a qualified informant (Flick, 2013) at UBB with whom we have worked in order to select the interviewees. All interviews lasted between 60 and 110 min and gender balance was taken into account.

Based on the three models identified by Felt et al. (2016) and on the concept of knowledge regime (Felt et al., 2013), we built a first set of dimensions of analysis. This process was conquered by several iterative phases of coding and induction (Table 2). Data collected was qualitatively analysed using content-analysis based on these dimensions (Flick, 2013; Mayring, 2000).

Setting

Babes-Bolyai University (Cluj, Romania) is an academic public institution that aims at promoting and sustaining the development of specific cultural components within the local, regional, national and international community (Babes-Bolyai University, 2020). UBB is the oldest and the largest university in Romania and considers itself as strongly embedded in society. Students at UBB experiment with transdisciplinary approaches, both from a theoretical and methodological point of view, and communication with local communities (Babes-Bolyai University, 2020).

The linguistic and cultural diversity are defining elements of UBB together with an emphasis on multiculturalism. The multicultural community in Transylvania is the subject of action that UBB recognises and takes responsibility for (Babes-Bolyai University, 2020). One of the main missions of UBB is to design solutions for local communities and society as a whole (Babes-Bolyai, 2020). This is why UBB fosters

Table 2. Dimensions and categories of analysis.

Dimension of analysis	Categories
Conceptualisation of TD	Definition of TD
	Definition of transformation / transformative research
	Principles
	Objectives
Institution	Relationship between actors
	Types of agencies
	Relationship with local / global contexts
	Strategies and instruments
	Challenges of TD institutionalisation
	Difficulties and gaps
	Successful initiatives
Cultures and communities	Values
	Timescales for TD
	Spaces for TD – interaction with the region
	Power constellations
	Norms
	Assessment
	Skills and abilities for TD

transdisciplinary research and teaching, for instance in land use (Balázsi et al., 2021) and natural resources management projects (Ruşdea et al., 2009).

UBB collaborated with Leuphana University of Lüneburg (Germany) in the course of the research project 'Leverage Points for Sustainability Transformation' between 2015 and 2021 (Abson et al., 2017). One reason to select this university as the case-study was the outstandingly strong collaboration between UBB and public–private actors, local governments, companies and the university's orientation towards sustainability (Abson et al., 2017; Horcea-Milcu et al., 2019).

We investigated seven research projects of UBB that developed a transdisciplinary approach to deal with sustainability problems in the period 2017–2020. In the course of our investigations we also involved researchers with other thematic orientations.

Findings

We organise our findings under the three models that characterise the relationships between science and society and three dimensions of analysis: (i) conceptualisation of TD; (ii) the institutional aspects and their logic; and (iii) the actors involved in these practices (Felt et al., 2016).

Model 1: Linear translation model

Conceptualisation of transdisciplinarity and its principles

Within this model, we identified interviewees who consider TD to be a relevant approach to connect with different communities where actors need 'to be taught' (Interview 2, 2018). According to our findings, transdisciplinary research at UBB has been increasingly motivated by demands for applicability and social relevance in environmental research. Research fields such as environmental impact assessment, soil remediation, ecosystem services and wood pastures require a comprehensive and holistic view. To achieve the research objectives, interviewees collaborated with researchers from different domains, decision makers and local population in a unidirectional manner.

Communication processes with people in rural areas – 'with local people' (Interview 12, 2018) – are perceived as particularly complicated and constitute one of the identified challenges. Some interviewees consider that their projects are still in an initial stage of transdisciplinary knowledge production, due to the fact that communication with stakeholders is mostly unilateral.

As main skills to develop a transdisciplinary approach, researchers considered important: (i) to develop good communication processes with colleagues and societal actors, (ii) to synthesise research results, and (iv) to build a holistic vision of the problem.

Under model 1, researchers collect data separately depending on their field of knowledge. When inquiring about the transdisciplinary principles guiding research practices, interviewees consider that the results of their study need to be applied directly to the communities.

Institutional logics in relation to transdisciplinary research

UBB is working towards the resolution of local sustainability problems. It has its own funds and it uses them for projects to accomplish sustainability goals. Interviewees

that develop projects under model 1, consider that the university's support is adequate and relevant. Interdisciplinarity is used in this model, as the main strategy to guarantee the research development.

The implementation and development of TD within UBB constitutes a great challenge, according to the interviewees. It is a large university with 21 different faculties and profiles. This heterogeneity produces a diversity of perceptions around TD. Nevertheless, the implementation of multidisciplinary projects, collaboration with certain institutions and decision-makers and collaboration with enterprises has helped to build an institutional understanding of transdisciplinary research.

Actors, communities and cultures

A strong aspect in this model concerns the values that researchers seek to reproduce in the local communities. Researchers identify several challenges related to transdisciplinary knowledge production processes, namely: (i) challenges related with communication processes among different actors, (ii) the time frames when special activities are being developed; and (iii) the spaces where these shared activities take place. Researchers usually implement their transdisciplinary activities in a public place.

Model 2: Delimited neutral arena model

Conceptualisation of transdisciplinarity and its principles

Although this second model bears differences with model 1, we can confirm that the perception of TD is closely related to the previous model. TD is considered a means to achieve a more holistic understanding of complex problems, and this process is leaded by researchers with participation of societal actors. These actors take part mainly as informants and depositaries of knowledge.

By comparing practices to model 1, we confirm that, in model 2, several efforts are developed to build transdisciplinary settings but still not all of those experiences are successful. What differentiates the two models is the kind of relationships built between societal and scientific actors. In model 2, there is a strong belief that a transformation can only be achieved when different actors jointly construct their reality. The lack of systematised practices and a clear understanding of the potentialities of TD often jeopardises this goal.

Institutional logics in relation to transdisciplinary research

Our findings confirm a variation with the model detailed by Felt et al. (2016). In one of the projects that were analysed, researchers and students participate in a Non-Governmental Organisation (NGO), funded and managed by students. In this particular experience, the NGO has the custody of a nature-protected area to develop a sustainable approach to its development. This structure can be considered a new approach towards co-production knowledge processes where the neutral arena is represented by a NGO as a new organisational structure.

Actors, communities and cultures

We identified projects where students' participation is relevant for the transdisciplinary process. They constitute a privileged group towards which many actions of the model are

oriented. For instance, specific skills and goals are put into practice to support them to consolidate small research projects. In this model, students are also responsible for building linkages with local communities.

In our analysis, the question arises as to how to solve the knowledge gap between societal and scientific actors, how to bridge the knowledge each of them has and how to better create a joint understanding of the problem. This is a powerful relationship that is not very clear in terms of shared worldviews in model 2. It affects the way in which researchers are able or not to perform their research under certain circumstances of conflict between local actors.

We identified research projects where time frames and spatial scales are built with the collaboration of NGOs. Research timing is also depending on the funding researchers get, as we identified for model 1.

Model 3: Shared epistemic arena model

Conceptualisation of transdisciplinarity and its principles

TD is a means to achieve sustainable solutions to the problems of the region. Although, very few projects could be categorised under this model, the examples extracted from the empirical analysis constitute a relevant contribution to our study.

> I use the knowledge that is generated by the previous research and then engage the people, institutions, farmers, owners of the pastures, foresters, and so on, to see how they see the challenges and solutions of the system and see how we could agree on the central solutions for the ecological, cultural and economically areas. (Interview 2, 2018)

In this quote, the researcher acknowledges the perspectives of different actors, different dimensions of the problem and inherent conflicts to be solved within the local context. The relevant aspect is how relationships among actors are understood and how these are part of a bigger system.

Researchers that can be associated with model 3 are interested in developing a strong relationship with different actors and to jointly frame the research problems. Researchers and societal actors build solutions based on different perspectives on the problem, which constitutes a relevant feature of the particularities that the model presents at UBB.

The main challenge identified by the interviewees is how to deal with different mindsets and values in the region. Further, research collaborators from local communities do not get any financial benefits for actively participating in these often time consuming research projects.

Institutional logics in relation to transdisciplinary research

Under model 3, institutions play the main role in the transdisciplinary relationship but with different features according to the project that is being funded. We found examples of organisational structures that contribute with the development of co-production processes but still need to define their purpose in terms of affiliation. NGOs are also present as detailed for model 2.

Actors, communities and cultures

Researchers' practices aim at bridging conflicts in the region as part of their transdisciplinary approach. This aspect constitutes an original feature for this model. TD, under this model, is mainly focused on generating knowledge about the communites and to try to identify the threats, problems and challenges to maintain societal actors' values.

Discussion

To answer the questions guiding this article, we focus our study on the 'problem-solving' discourse (Klein, 2014) and three models of science-society relationships (Felt et al., 2016). Within UBB, we analysed them in the light of two types of TD – an additive and entangled approach: transdisciplinary research that is embedded in larger social research constellations, but not affecting the scientific rationality, and one that is based on an open relationship between the cultures of knowledge, which does not grant primacy to any specific form of knowledge and knowledge generation (Vilsmaier, 2021). This distinction allows us to advance the understanding of institutionalisation processes related to TD at universities (Table 3).

The analysis performed at UBB confirms that different approaches to TD are represented in the research activities realised at this university with different relationships between scientific and societal actors. These differences impact the ways in which TD is institutionalised and the timeframes and spaces that are embedded into the organisational structure (Felt, 2017).

Table 3. Models of transdisciplinary knowledge production and science-society relationships (Felt et al., 2016) in the Romanian case study.

	MODEL 1 Linear Translation	MODEL 2 Delimited Neutral Area	MODEL 3 Epistemic Shared Arena
Additive TD	Initial state of TD. TD is motivated by demands for applicability and social relevance in environmental research.	TD is motivated by demands for applicability and social relevance in environmental research.	–
	Small and specific funding. Interdisciplinary focus mainly.	Small and specific funding. Interdisciplinary focus as prerequisite for TD.	–
	Unidirectional collaboration among researchers, decision makers and local population. Actors need 'to be taught' Students participation	Students actively participate in these projects.	–
Entangled TD	–	Transformation must be done in the way different actors construct their reality.	TD is a means to achieve sustainable solutions to the problems of the region. Co-production.
	–	Consolidation of NGO as a neutral arena.	Small funding schemes Consolidation of epistemic shared arena built from NGO.
	–	Students actively participate in these projects. Specific skills and goals are put into practice to support them to consolidate small research projects.	Strong bidirectional relationship with different actors to find solutions based on disagreements between the perspectives on the problem.

Most of the transdisciplinary research projects developed at UBB imply a model 1 and model 2 understanding of the relationship between societal and scientific actors. This additive understanding of TD implies a dominantly unidirectional pattern. Roux et al. (2006) identified this relationship as transferring knowledge from the scientific realm into the societal one, in which mutual learning processes between actors are not explicitly aimed at. In both models found at UBB, researchers adapt their scientific research process in order to transform it into a transdisciplinary one.

In line with previous case studies, transdisciplinary research is still at an initial stage at UBB and researchers perceive that the process still has to be developed mainly by them (Vienni Baptista & Rojas, 2019). Societal actors contribute with ideas and perspectives on the problem but they are mostly led by researchers. Following Mielke et al. (2016), actors are divided into knowledge producers and knowledge consumers but little space is given to co-production processes and mutual learning. As shown in Table 3, at UBB, the institutional logic considers local communities as in need of 'being educated'. Our case study confirms that the guiding ideologies and myths – considering societal actors as relevant knowledge providers but not as research partners – cross-cut research practices.

We identified several funding and support activities that motivate researchers to adopt an interdisciplinary approach. In additive TD, societal actors are outside the core of knowledge production and the disciplines still play a substantial role in integrating the different types of knowledge. Hegemony of science is questioned but still not transformed into entangled practices, where space in-between institutions and cultures of knowing is opened up to negotiate and reshape knowledge production for societal transformation (Vilsmaier, 2021).

Projects at UBB aim at developing a comprehensive and holistic view of the research problem. Although this constitutes a relevant feature of TD according to scholars (e.g., Bammer, 2019), at UBB researchers find it difficult to transform transdisciplinary research (from additive to entangled) or to move from model 1 to model 3. Most research projects promote an additive understanding of TD where scientists determine the aims and goals of the study.

Our findings confirmed that model 3 practices are being developed at UBB, representing first signs of an entangled practice of TD. These are promising institutional spaces to constitute co-production processes in which practices, values and representations are redefined (Jasanoff, 2010). Societal actors play a central role in such co-production processes where mutual learning and integration is realised between academic and community-based cultures of knowing, acting and being. These are the space where different conditions – such as temporal and spatial framings – are acknowledged and where power relations are negotiated and reframed (Balázsi et al., 2021; Fritz & Meinherz, 2020).

Model 3 projects and entangled transdisciplinary practices (Table 3) allow for co-production among equal parties with different roles during the research process. This mode of TD implies that researchers build new types of relationships with societal actors in bi-directional learning processes (Roux et al., 2006). The practices we have analysed indicate that researchers invest significant time and effort to build a mutual understanding of the problem together with societal actors. It is a key feature of TD to jointly build definitions and framings of research problems (Hirsch Hadorn et al., 2008), enabling mutual

understanding of commonalities and differences of problem perception and pathways to transformation.

Our analysis shows that societal actors are empowered to contribute to required transformations while challenges of transdisciplinary knowledge production are overcome. Entangled TD also proves that knowledge processes can be transformed according to cultural practices and local demands (Rivera Silva et al., 2018). In UBB, several bridges were built to address these challenges such as alternative organisational structures (NGOs) and meetings in public places. These have proven useful to reframe collaborative research and to allow for mutual, social learning (Akpo et al., 2015).

The features of transdisciplinary knowledge production at UBB show specific context-related aspects that determine the ways transdisciplinary processes are implemented. UBB faces the challenge of a two-fold process of institutionalisation of TD (Vienni Baptista & Rojas, 2019), seeking to balance the policy that is implemented with the type of practices that are being developed to address complex problems in an iterative process. This is related to TD being integration with and into society (Klein, 2014) – another crucial element. In this respect, UBB makes a significant effort in order to institutionalise research practices developed together with societal actors and the need to reach higher levels of consolidation.

We consider this last aspect the key issue to answer the second question that guides our study. This is potentially a step backwards in the integration of the disciplines – a key component of TD research – since researchers at UBB interested in collaborating with others will be more likely to remain rooted in their own disciplinary fields (Aeberhard & Rist, 2009).

TD institutionalisation is an iterative process. Our findings have confirmed outcomes of previous case studies (Vienni Baptista et al., 2020; Vienni Baptista & Rojas, 2019). Current practices at UBB stem from the formal set-up or initial consolidation phase (usually implemented by university authorities). Over time, as these practices acquire a degree of legitimacy, the formal set-up becomes too narrow to accommodate them or to allow the emergence of new transdisciplinary-related practices (Vienni Baptista & Rojas, 2019). Therefore, transdisciplinary institutionalisation processes should iterate between formal set-ups that are constantly renewed responding to model 3 practices, as the ones that researchers at UBB are implementing together with societal actors.

Conclusions

With this article, we seek to contribute to the discussion on transdisciplinary knowledge production and its institutionalisation. The transformation from the traditional disciplinary-based university towards problem-orientation, deploying transdisciplinary principles and practices requires tackling a wide spectrum of factors – from policy, strategy, economic incentives to professional identity and reframing relationships between universities and other societal institutions and communities. Our analysis shows that the institutionalisation process of TD at UBB is still in an early phase of development with dominant practices of additive TD. Several unique features of the UBB case study are relevant to refine the models, such as a new sub-type of model 2. Our study is in line with Felt et al. (2013) who argue that a new type of transdisciplinary knowledge regime requires to be analysed accordingly. This implies to further research on the topic of

institutionalisation to provide more insights into the relationship between the university and other societal actors and organisations. Though advances have been made, more micro level studies using qualitative research are needed to better understand the institutionalisation of TD within universities. This type of study has the potential limitation that models of transdisciplinary knowledge production are context-dependent and are difficult to compare (Schriewer, 2018).

To conclude, models of transdisciplinary knowledge production elaborated in this study constitute means to analyse institutionalisation at universities. These models help to identify in a fine-grained manner differences in the types of TD while contributing to the extensive discussion on the types of relationships between scientific and societal actors in research settings.

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