Bridging knowledge systems in sustainability doctoral education

Analysing doctoral theses originating from sustainability doctoral schools reveals that it remains a challenge to bridge knowledge systems within the framework of doctoral research. We argue that doctoral programmes should do more to support students in transcending knowledge boundaries.

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GAIA 35/2 (2026): 84–92

Abstract
The current polycrisis requires a recognition that no single knowledge system is sufficient for generating solutions. Bridging knowledge systems is central to inter- and transdisciplinary research. Yet, it remains challenging with academic structures still characterised by disciplinary silos. Doctoral education can train early-career academics to overcome these divisions and work across knowledge boundaries. We analyse 37 theses conducted in three consecutive sustainability doctoral schools at BOKU University, Vienna, focusing on how students managed to bridge knowledge systems. We find that most students were able to incorporate elements of interdisciplinarity and experiential knowledge, yet the depth and intensity of integration varied considerably. Knowledge co-production and reflexive engagement with inter- and transdisciplinary approaches were the exception rather than the rule. While bridging knowledge systems is extensively addressed in the doctoral curricula, it may have been sidelined by other factors such as publication requirements, time pressure and project contexts.

Keywords
doctoral schools, doctoral studies, interdisciplinarity, knowledge systems, science boundaries, transdisciplinarity

Science plays a vital role in identifying potential pathways for actions in the face of polycrisis (Lidskog et al. 2022, Lawrence et al. 2024). Dominant practices rooted in monodisciplinary approaches are often criticised for their limited capacity to address the multi-scalar nature of today's sustainability challenges (Troullaki et al. 2021, Hogan and O'Flaherty 2022). Building on collaborative and practice-oriented research, there has been a renewed emphasis on pluralistic approaches to knowledge production, grounded in the recognition that no single knowledge system is sufficient (Funtowicz and Ravetz 1993, Gibbons et al. 1994, Lang et al. 2012, Steiner 2025).

We understand knowledge systems as forms of producing, validating, and applying knowledge shaped by social and cultural contexts (Cash et al. 2003, Tengö et al. 2017, Chapman and Scott 2020). Each knowledge system (e. g., scientific, local, professional, and indigenous) produces a characteristic type of knowledge while all knowledge systems can contribute to system, target and transformation knowledge (Pohl et al. 2017). Bridging knowledge systems (BKS) can be understood as the process of connecting and integrating knowledge from different knowledge systems to create novel understandings and solutions (Berkes et al. 2000, Tengö et al. 2014). It encompasses a spectrum of interactions, from interdisciplinary (ID) scientific collaboration to transdisciplinary (TD) research initiatives (Salmela et al. 2025). Central is the co-production of knowledge, whereby different epistemolo-

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https://doi.org/10.14512/gaia.35.2.5
Received August 5, 2025, revised version accepted March 5, 2026 (double-blind peer review).

gies are mutually respected and actively utilised to create integrative understandings (Bandola-Gill et al. 2023).

BKS should not be equated with seamless integration but instead requires epistemic plurality, sensitivity to power relations, and context-specific negotiation across knowledge systems (Pedregal and Degele 2025, Ligtermoet et al. 2025). Hence, the operationalisation of BKS remains a challenge, and calls for attention to reflexive practices in response to issues of normativity and power. This raises questions about how such capacities can be systematically taught, learned, and embedded in academic training (von Seggern et al. 2023, Lazurko et al. 2025). Universities and their training systems play a vital role in fostering BKS, especially at the early stages of research careers, when epistemological orientations and research practices are being formed (Fortuin and Van Koppen 2016). They are not only sites of knowledge production but also key learning environments for developing reflexive, collaborative, and systems-oriented competencies required to engage with epistemic plurality (Wiek et al. 2011, Gulikers et al. 2025). Doctoral education has been identified as a critical site for cultivating capacities for knowledge co-production, as it combines advanced research training with increasing expectations for societal engagement and impact (Kemp and Nurius 2015, Rogga and Zscheischler 2021). Examining how doctoral students engage with diverse knowledge systems can thus provide insights into the successes, challenges, and potential pathways for embedding knowledge co-production within academic training.

BOKU University (Vienna, Austria) offers an interesting case, given its strong tradition of ID research and education, integrating natural sciences, engineering, and social sciences to address issues related to natural resource management, environmental protection, and sustainable development.[1] Thematic doctoral schools have been established at BOKU with the aim of fostering engagement with diverse knowledge systems, stimulate ID and TD research, and equip doctoral students with the skills needed to contribute to real-world sustainability challenges (Muhar et al. 2013).[2] This study focuses on three such schools:

- The ***Doctoral School of Sustainable Development (dokNE),*** 2007 to 2010, promoted research addressing sustainability challenges through ID approaches, with an emphasis on climate adaptation, land and water management, and environmental governance. Students were fully funded through a research programme supported by the federal ministries and states. *DokNE* mainly focused on local cases, with German as its working language. The topics of the theses were defined by the faculty team, funding consortium and practice actors. Theses could be submitted as a monograph or cumulative publications.
- The ***Doctoral School of Sustainable Development II (dokNEII),*** 2011 to 2014, built upon the experiences of *dokNE* and placed greater emphasis on participatory approaches, stakeholder engagement, and socio-ecological systems thinking. Students were funded through a combination of university, federal and non-governmental organization resources as well as third-party projects. *DokNEII* had English as a working language and an international student body. Topics were partially predefined and partially developed by the students with their supervisors. Theses could be submitted as a monograph or cumulative publications.
- The ***Doctoral School Transitions to Sustainability (T2S),*** ongoing since 2018, integrates transition studies, systems thinking, and transformation research more explicitly, reflecting a shift towards understanding and supporting societal transitions at multiple levels. Students are predominantly funded through third-party projects or scholarships. Topics are developed by students and their supervisors, and theses are cumulative publications. *T2S* provides some funding for fieldwork, publications, conferences, and group activities.

The three doctoral schools provide(d) coursework, seminars, and networking opportunities to expose students to ID and TD theories and methodologies as well as systems thinking. However, the extent to which the doctoral theses manage to engage with BKS remains an open question. Against this backdrop, we ask to what extent and how different knowledge systems were bridged in the theses of these doctoral schools. We investigate this by analysing 37 doctoral theses completed within the schools. Furthermore, we examine the extent to which BKS was reflected upon by the students. We aim to contribute to a better understanding of how doctoral education can support BKS and transformative research for sustainability, and to identify lessons learned for designing ID and TD doctoral programmes.

Methodology

As an ID team of senior scientists, current and recent doctoral students, we screened doctoral theses of the three schools. The analysis was guided by a conceptual framework on BKS, knowledge integration, and co-production (Enengel et al. 2012, Tengö et al. 2014, Lang et al. 2012). The five categories are presented in table 1 (p. 86). Using deductive coding based on this framework, we assess the disciplinary orientation of the theses, the knowledge types integrated, the involvement moments of different knowledge systems during the research process, the intensity of interaction, and the types of knowledge outcomes.

Theses completed before August 2024 were included. Incomplete (n=3) or inaccessible (n=1) theses were excluded. The unit of analysis was the complete doctoral thesis which was either a monograph or a cumulative dissertation consisting of published articles accompanied by framework chapters which contextualise and discuss the publications. In total, we analysed 37 doctoral theses completed between 2009 and 2024: 14 from the *dokNE* programme, 9 from *dokNEII,* and 14 from *T2S*.

1 *https://boku.ac.at/en*

2 See also *https://boku.ac.at/en/docservice/doctoral-studies/doktoratsschulen/transitions-to-sustainability-t2s*.

TABLE 1: Analytical categories used for data extraction and their definitions.

CATEGORIES	DEFINITION	CODES AND DEFINITIONS	LITERATURE
three pillars	classification of scientific discipline that the thesis is embedded in	***natural science*** ***social, economic and legal science*** ***technological and engineering sciences***	BOKU (2025)
knowledge inputs	the type of knowledge that was integrated into the thesis	***scientific from one discipline (SO)*** ***scientific from multiple disciplines (SM)*** ***experiential indigenous (EI):*** knowledge rooted in lived experience and practices associated with indigenous people and their cosmologies ***experiential local/traditional (EL):*** knowledge rooted in lived experience and practice, often tacit knowledge associated with a certain locality and culture ***experiential professional (EP):*** knowledge rooted in lived experience and practice of non-scientific actors, stakeholders, decision makers, NGOs, politicians, as well as practitioners from various fields that are not academic	Enengel et al. (2012), Lang et al. (2012), Tengö et al. (2014), Raymond et al. (2010), Semali and Kincheloe (2002)
involvement moment	the different points of the research process where interaction with different knowledge systems took place	***problem identification:*** involvement during the initiation of the project, justification and formulation of research questions, e. g., framing the research question ***research design/methodology:*** choice of how research question will be addressed, timeframe, workplan, case studies, choice of methodology ***data collection:*** involvement in the data collection, e. g., different forms of data generation with practitioners or also citizen science ***analysis:*** involvement in interpretation of results ***reflection:*** involvement of actors in evaluation, validation and discussion of results, e. g., bringing back and discussing the results with the actors ***publication/dissemination:*** involvement in communicating the results, e.g., joint publication with the involved actors/reports/presentations etc.	Enengel et al. (2012), Lang et al. (2012)
intensity of interaction	the degree of engagement between the doctoral students and other actors in the research process	***information:*** information represents the lowest level of intensity where actors have little or no opportunity to influence research process. E. g., written reports, public meetings, interviews, surveys ***consultation:*** non- academic actors have the opportunity to comment on the research design (objectives, questions, methods) and also to evaluate the scientific results. However, they are not entitled to change the design or the results. Empirical data collection for the production of results is not considered consultation. ***knowledge co-production and empowerment:*** actors have a say in the design of the research project, participate in the development of the results, and become partners in the research project. E. g., workshops, co-authorship of research proposals, practitioners are partners in the research project, participatory scenario development.	Stauffacher et al. (2008) Enengel et al. (2012), Lang et al. (2012), Arnstein (1969), Mobjörk (2010)
knowledge outcome	type of knowledge that was created through the interaction	***system knowledge*** describes knowledge that can help answer questions about the origins, current status, and possible future development of a problem, including questions about different interpretations of that problem. "Where are we?". ***target knowledge*** helps to identify desired goals and necessary changes or the introduction of better practices "Where do we want to go?". ***transformation knowledge*** answers the general question, "How do we get where we want to go?". More specifically, it addresses questions about the technical, cultural, social, legal, and other means necessary to transform existing practices and conditions into the desired ones.	Enengel et al. (2012), Pohl et al. (2017)

Data extraction was carried out by the authors in a two-cycle process. First, each thesis was assigned to a team of two authors who applied the subcategories (i. e., codes) to the theses and entered the results into a shared database. As a whole group, we discussed uncertainties encountered during this process and refined the category definitions. Then, each thesis was reassigned to a different team of authors for verification. These teams repeated the extraction process, checked for inconsistencies with the initial coding, and discussed discrepancies with the original team. Subsequent data analysis was conducted collaboratively by the author teams to identify central patterns and themes. Methods were clustered to reveal how knowledge types were integrated.

Patterns of bridging knowledge systems in doctoral theses

Disciplinary orientation of doctoral theses

Following BOKU University's distinction between three pillars, our analysis shows that 89 % of the theses were based within social sciences, 32 % in natural sciences, and 16 % in technological/engineering sciences. 32 % of the studies were attributed to more than one of these categories.

Context and framework conditions of the individual theses

Due to their funding structures, the doctoral schools offered different framework conditions. In *dokNE,* students held fully paid positions. In *dokNEII,* only about half of the students were funded by the programme; while the remainder were externally funded through fellowships and grants. In *T2S,* external funding is the norm, often embedding students within larger national or international research projects. Only one *dokNE* thesis was part of a larger research project. We identified four students (one in *dokNEII* and three in *T2S*) who worked in related fields or in organisations associated with their research prior to starting the doctorate, providing them with insights into the research context and direct access to stakeholders and professional knowledge.

Central topics of the theses based on each doctoral school

Our thematic analysis across the doctoral schools reveals key differences in their thematic focus on sustainability and environmental governance, partly shaped by funding sources and partners involved. While the overarching theme relates to *Integrated Sustainability Transitions: Governance, Climate Adaptation, and Socio-Ecological Innovation Across Sectors, dokNE* focuses on climate policy, land and water management, and sustainable tourism, with an emphasis on policy-driven solutions and strategic environmental assessments (see online supplement, table 1[3]). *DokNE* theses examine the effectiveness of governance mechanisms (2, 8, 10)[4], the role of technology in addressing long-term sustainability challenges (1, 13, 14) and anticipatory policy advice (1). Studies also highlight the impacts of climate change on tourism (3, 5, 9), agriculture (14), and urban green spaces (6), as well as strategies for reducing carbon emissions through renewable energy integration (13). Some theses (2, 8, 10) analyse large-scale policy implementation and regulatory frameworks rather than focusing on community-driven initiatives.

In contrast, theses in *dokNEII* and *T2S* reveal more bottom-up approaches to sustainability. Work in *dokNEII* centres on socio-ecological systems, participatory governance, and human-nature relationships, highlighting community-based, stakeholder-driven solutions to environmental challenges (11, 15, 16, 21, 22). There is also an exploration of citizen science (26), ecosystem services (15), and the role of participatory governance in fostering sustainability transitions (7, 19). In *T2S* there is an emphasis on agriculture, food systems, and energy transitions, investigating how economic, technological, and behavioural changes can drive sustainable resource use (23, 25, 28, 31, 36). Studies in this school analyse both local and global food networks (25, 28, 36), animal welfare (23, 32), energy system transformations (13, 36), and sustainable mobility (37).

Knowledge input

The analysis of knowledge types reveals that scientific knowledge from multiple disciplines was included in 23 theses, while ten incorporated scientific knowledge from a single discipline. Among experiential knowledge types, professional knowledge was most frequently integrated (31 theses), followed by traditional or local experiential knowledge (15 theses). Indigenous experiential knowledge appeared in only one thesis.

We also analysed the prominence of different knowledge inputs (figure 1, p. 88). The incorporation of scientific knowledge from one discipline (SO) was highest in *dokNEII,* where nearly half of theses at least partially relied on a monodisciplinary scientific approach. This was higher than in *dokNE* and *T2S,* where only few theses followed this approach. Scientific knowledge from multiple disciplines (SM) was incorporated into 64 % of theses in both *dokNE* and *T2S* and 56% in *dokNEII*. Within both *dokNE* and *T2S* there was a large difference between the proportion of theses that used scientific knowledge from one discipline compared to those that involved multiple disciplines. In *dokNEII* this difference was much less pronounced. Meanwhile, experiential traditional and local knowledge (EL) was most frequently integrated in *dokNEII*. In comparison, *dokNE* and *T2S* each had fewer theses incorporating this type of knowledge input. The integration of experiential professional knowledge (EP) was the most widespread type of experiential knowledge frequently integrated across all doctoral schools.

A substantial majority of theses (84 %) across the schools incorporate more than one type of knowledge input. *DokNEII* demonstrates the highest level of knowledge integration, with all of its theses including multiple types of knowledge inputs. This indicates a strong ID and experiential orientation within this doctoral school. *DokNE* follows with 86 %, while *T2S* has 71 %. >

3 Online supplement available at *https://doi.org/10.14512/gaia.35.2.5.*

4 Numbers in parentheses refer to the identifiers assigned to the analysed dissertations.

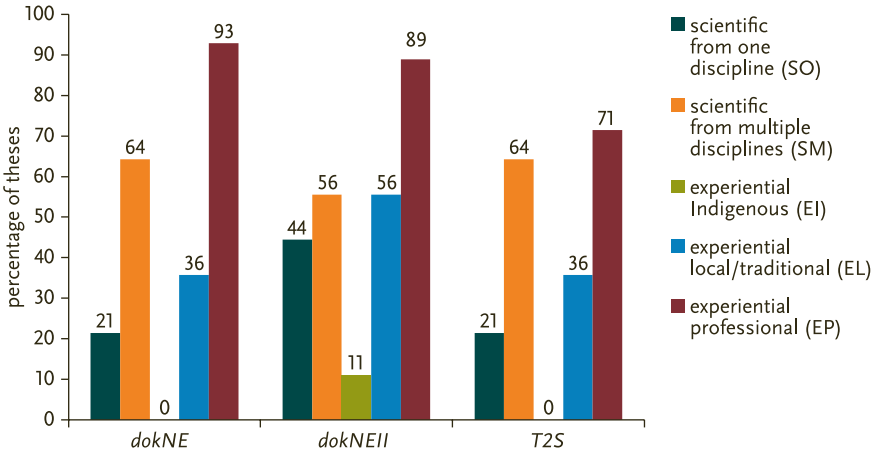


FIGURE 1: Types of knowledge input by doctoral school. *dokNE: Doctoral School of Sustainable Development, dokNEII: Doctoral School of Sustainable Development II, T2S: Transitions to Sustainability.*

In total, we identified nine distinct combinations of bridged knowledge systems. The most common combination, SM and EP knowledge, appears prominently across all three doctoral schools. Other notable combinations include SM, EP and EL knowledge as well as SO, EP and EL knowledge, reflecting a layered approach to integrating both scientific and experiential knowledge. Overall, most theses display a strong tendency towards knowledge bridging, with variation in the knowledge systems involved.

Involvement moment across research phases

The interaction with different knowledge systems varied across research phases (figure 2). It was most prominent during the data collection phase, followed by reflection and problem identification. External stakeholder involvement was relatively limited in the research design and methodology development phase. The analysis and the publication or dissemination phases showed the lowest levels of involvement. Compared to *dokNE* and *dokNEII,* theses from *T2S* involved fewer actors in phases beyond data collection. Only 16 theses engaged external actors across multiple phases of the research process, of which ten involved external actors in more than two phases. One thesis from *dokNE* stands out for engaging actors across all research phases.

How was knowledge generated?

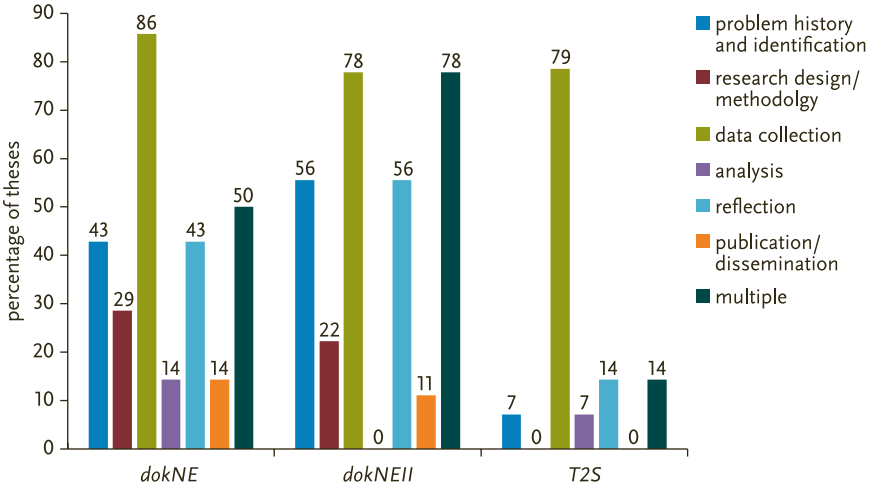
In many cases, individual theses employed a method more than once or multiple methods across different publications (see online supplement, table 2[3]). We also examined the intensity of interaction between doctoral students and other actors coupled with the methods used by those theses that had a high intensity of interaction. Only a few cases involved co-production. These predominantly employed interviews (88 %), case study approaches and reviews (63 % each) or surveys and workshops (50 % each). 19 theses had the characteristics of consultation. These frequently used interviews (84 %) followed by workshops (58 %) and case study approaches (47 %). Most theses had a low intensity of interaction (information). Interviews occurred most frequently here (90 %), followed by surveys, workshops and qualitative content analysis (41 %) and case study approaches (36 %). Figure 3 shows a higher intensity of interaction in theses from *dokNE* and *dokNEII* doctoral schools than in those from *T2S,* where we identified only one case of co-production. In contrast, interaction in *T2S* was most frequently limited to information.

Knowledge outcome

In terms of knowledge outcomes, system knowledge was the most frequently produced output across all three schools, followed by transformation knowledge and target knowledge. System knowledge was most prevalent in *dokNE* and *T2S,* and somewhat less common in *dokNEII.* Target knowledge appeared most frequently in *dokNE,* followed by *T2S* and *dokNEII.* In contrast, transformation knowledge was most prominent in *T2S,* with fewer contributions from *dokNE* and *dokNEII.*

The most common combination of knowledge outcomes was system and transformation knowledge, followed by system and target knowledge. A small subset of theses yielded all three types, while target-only knowledge was the least common.

FIGURE 2: Involvement moment of different knowledge systems in research process across doctoral schools. *dokNE: Doctoral School of Sustainable Development, dokNEII: Doctoral School of Sustainable Development II, T2S: Transitions to Sustainability.*



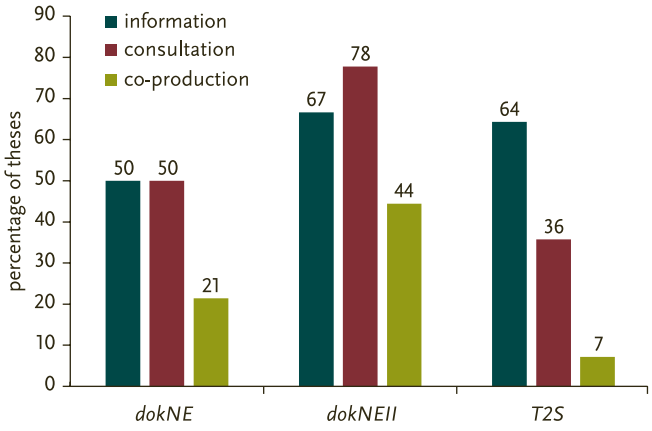


FIGURE 3: Intensity of interaction across doctoral schools. *dokNE: Doctoral School of Sustainable Development, dokNEII: Doctoral School of Sustainable Development II, T2S: Transitions to Sustainability.*

Reflection on the bridging of knowledge systems

In 35% of theses, there was an explicit reflection on the research process and its positioning in ID and TD approaches. In most cases, this occurred in a separate chapter. In 43% of the theses, we found no reflection on inter- or transdisciplinarity. In 19% of theses, there was partial reflection on the necessity of ID and TD approaches in the context of the research, but no reflection on the research process or how inter- or transdisciplinarity were addressed. The lack of reflection was most prominent in *T2S,* where 57% of theses did not discuss or reflect on their work in ID and TD approaches. In *dokNE,* a higher proportion of theses (64%) included either partial or detailed reflection, compared to 36% that did not.

Discussion

The results illustrate whether and how ambitions towards BKS in doctoral sustainability research are reflected in doctoral theses. Most theses drew on more than one knowledge system, often combining multiple disciplines with experiential professional knowledge, indicating that many doctoral projects engage with BKS. However, the bridging identified in the written work often remained limited in scope and intensity. Although multiple actors were frequently involved in data collection, they less frequently participated in reflection, problem framing, research design, dissemination and analysis. *DokNE* presents a specific case in which research topics were formulated between faculty and stakeholders; yet based on our analysis, this involvement was often not made visible in the theses. Findings from *dokNEII* and *T2S* reinforce earlier research, showing that actor involvement in TD research is often concentrated in the mid-stages of research, thereby undermining the potential for knowledge co-production across the entire process (Enengel et al. 2012, Tengö et al. 2014, Bandola-Gill et al. 2023). Despite the limited diversity of involved actors, and therefore knowledge systems, we find a high diversity of knowledge outcomes. Notably, transformation knowledge also emerged from monodisciplinary research, just as systems knowledge was the result of interactive TD studies (Pohl et al. 2020), indicating that transformative potential does not depend solely on the bridging of different knowledge systems.

The intensity of interaction between knowledge systems was generally low, exposing a gap between ambition and practice. Co-production was only observed in about one-fifth of theses, which included methods such as workshops or case study designs that enabled closer actor engagement. The reliance on qualitative interviews raises questions about method diversity and engagement. While interviews facilitate access to experiential knowledge, they typically function as a one-way mode of knowledge transfer. This reflects a broader issue whereby interviews are mistaken for participation but rarely foster mutual learning and dialogue (Enengel et al. 2012). This is notable given that doctoral students in the three schools were introduced to various participatory methods in their curriculum, including scenario building, living labs, and collaborative modelling, methods known to better enable BKS (Lang et al. 2012, Schäpke et al. 2018). Yet we found sparse application of these approaches.

While differences among the doctoral schools are relatively minor, some patterns emerge. Theses from *dokNE* and *dokNEII* featured higher interaction intensities and more frequent integration of professional and traditional experiential knowledge. *T2S* theses featured the fewest combinations of knowledge systems, lower incorporation of experiential professional knowledge, and the least evidence of co-production. This may be linked to funding and capacity constraints, as *T2S* theses were more often embedded in externally funded research projects, in which problem framing, methodology, and actor engagement are partially predetermined (Kruijf et al. 2022). This could have reduced students' autonomy to adapt or extend their research design in line with ID and TD principles (Fritz and Meinherz 2020, Jaeger-Erben et al. 2018). A recent external evaluation of *T2S* also identified the programme's high reliance on external funders as a risk to its coherence (Davoudi et al. 2023).

Tightly defined research outputs and rigid timelines constrain doctoral students' ambitions to what is feasible (Kovacic and Marcos-Valls 2023). Flexibility, whether in terms of time, funding, or research design, is widely recognised as an enabling condition for actor involvement and knowledge co-production (van Breda et al. 2016, Djinlev et al. 2023). *DokNE* benefitted from dedicated internal funding, which resulted in greater flexibility for doctoral students. Additional mechanisms, such as project-specific advisory boards and support, further strengthened these conditions (Muhar et al. 2013). These conditions exemplify institutional support for developing the competencies and reflexive capacities required for engaging in ID and TD sustainability research (Horn et al. 2022, Kovacic and Marcos-Valls 2023). The TD *Doctoral Programme in Sustainability* at Stellenbosch University, South Africa and the Zurich-Basel *PhD Programme in Science and Policy* show how close and institutionalised collaboration with societal actors through co-supervision, internships and contin- >

uous dialogue can prepare students for TD boundary work (Muhar et al. 2013, Paschke and Zurgilgen 2019).

Most theses lack a documented reflection of the research process. This is problematic given that reflection on the research process is an important component in fostering capacities for BKS in the context of TD research (Horn et al. 2022). Apart from not being mandatory, this gap can be attributed to three interrelated factors. Firstly, disciplinary publishing norms leave little space for such reflection, particularly on ID and TD aspects, prioritising methodological rigour and results over process-oriented insights (Djinlev et al. 2023). Thesis in the form of monographs provided more space for this reflection. Secondly, time constraints, especially towards the end of the doctoral process, limit opportunities to document reflexivity in the final thesis (Pohl et al. 2018), even when students are aware of its relevance. Thirdly, reflexivity does not appear to be a shared institutional priority, but rather a personal choice dependent on the supervisors. As Lazurko et al. (2025) note, all research is interventionistic, therefore, as we increase engagement with non-scientific knowledge systems, reflexivity becomes crucial. In this regard, it would be particularly helpful to include concepts such as boundary delineation, which describes the researcher's background and initial assumptions, as well as the boundary interaction, including decentring dominant frames and subsequently expanding and weaving of frames (Lazurko et al. 2025). Evaluation criteria could make space for reflective accounts and non-traditional formats, such as policy briefs, articles for non-academic audiences, or artistic forms of communication, alongside academic publications. While such outputs cannot replace peer-reviewed work in doctoral theses, their formal recognition would help to foster TD efforts.

Our results align with broader critiques that BKS, especially in the context of TD research, is often only partially implemented in early-career research contexts (Rogga and Zscheischler 2021, Jaeger-Erben et al. 2018). Doctoral students often face structural constraints, including disciplinary publication norms and career paths that reward traditional scientific outputs (Rogga and Zscheischler 2021, Kruijf et al. 2022, Djinlev et al. 2023). This points to a paradox many young sustainability scholars in academia are confronted with and that contrasts with values deemed necessary for sustainability transformations including those of care and deceleration (Wassénius et al. 2023). In 2024, a working group of BOKU students and staff developed an action plan for transformative research, calling for alternative evaluation metrics, career paths, and innovative funding models to support research across knowledge systems (Beringer et al. 2024).

Conclusion

Our study offers an empirical basis for examining how sustainability doctoral education has evolved and how the respective doctoral research engages with BKS. By focusing on three consecutive doctoral schools spanning 15 years at BOKU, the longitudinal perspective provides insights into the development of doctoral education for sustainability transformations. BOKU represents an informative case due to its historical positioning at the intersection of multiple disciplines and its close ties to national and international stakeholders. This allows reflection on how institutional conditions, funding structures, and programme designs shape knowledge co-production in doctoral schools. The study contributes analytically by documenting recurring patterns in BKS within doctoral theses and highlighting persistent gaps between the ambitions of doctoral training and what is ultimately realised and documented in the theses.

As universities are increasingly challenged to shift from "science for society" to "science with society" (Scholz 2020), doctoral schools are becoming key sites for overcoming science boundaries and supporting transformative research. Understanding how doctoral students engage with BKS is important for the further development of doctoral education for sustainability. It sets the basis for further research on the transformative impact of TD research and for creating conditions for doctoral students to apply ID and TD approaches.

Acknowledgements: We would like to thank *Maria Wurzinger, Gustavo Gutierrez* and *Stefan Strohmeier* for their contributions in the early stages of the analysis. We also want to thank *Andreas Muhar* for his valuable comments and feedback. Finally, we thank three anonymous reviewers for their helpful comments.
Funding: This work received no external funding. Open access funding was provided through the *Transitions to Sustainability Doctoral School (T2S)* at BOKU University.
Competing interests: The authors declare no competing interests.
Authors' contributions: *AM, CV, EM, CSP, MW:* initial research design, data collection and analysis, manuscript drafting and writing the final manuscript; *MF, TT, WZ, CW:* initial research design, data collection and analysis, revising manuscript.

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