Advancing transdisciplinarity: Learning, teaching, and institutionalizing

In defining values and skills for grappling with complex societal challenges, this article builds on Daniel Stokols' generic model of the 4 Ts of training for transdisciplinary, team-oriented, translational, and transcultural research. Whether explicit or implicit, the 4 Ts thread throughout this exploration of learning and teaching in transdisciplinary contexts. Stokols' focus was educating social ecologists, but his call to close the gap between rhetoric of endorsement and limited responsiveness of academic institutions is widespread. Learning for sustainability is a case in point. Although increasingly prioritized as an imperative, it is often confined to special programs rather than assimilated across the academy and its relations with other sectors of society. This contribution builds further on remarks in a panel at the 2021 International Transdisciplinarity Conference: *by synthesizing insights into inter- and trans-disciplinarity and subthemes of teaching and learning while embellishing Stokols' other three Ts of team-based approaches, translation of knowledge across sectors, and a shift from uni- to transcultural outlooks. In the course of discussion the contribution also clarifies differences between inter- and trans-disciplinarity, though treats them as emphases, not sharp boundaries.*

Julie Thompson Klein † ⓘD

I n defining values and skills for addressing complex societal challenges today, Daniel Stokols (2018) highlighted 4 Ts of training for transdisciplinary, team-oriented, translational, and transcultural research. The 4 Ts thread throughout this exploration of learning for transdisciplinarity in the 21ˢᵗ century, along with subthemes of teaching and institutionalizing. Stokols' focus was educating the next generation of social ecologists, but his exhortation to close the gap between rhetoric of endorsement and limited responsiveness of academic institutions is widespread. The rhetoric appears across countries in strategic plans of universities, reports of educational commissions and science-policy bodies, and numerous case studies. However, so do barriers and disincentives that limit prospects for new structures and practices. In the case of sustainability, for instance, calls for prioritizing complex problems are linked to the urgency of global climate change, pollution, and loss of biodiversity, with direct consequences for health, food security, viable communities, and ultimately survival of the planet. Yet, inter- and trans-disciplinary learning and teaching are often confined to special programs rather than assimilated across the curriculum and in academic

interactions with other sectors of society. This contribution to the *Forum* builds further on remarks in a panel at the *2021 International Transdisciplinarity Conference* on new modes of learning and teaching in institutions that foster integrative approaches to complex scientific and societal problems. In the course of discussion, it distinguishes inter- and trans-disciplinarity, but treats them as emphases rather than rigid boundaries.

Learning

The concept of learning is generally associated with formal settings such as a classroom. Ideal models of transdisciplinary venues include Erich Jantsch's (1972) vision of an ultimate degree of coordinating education and innovation to advance normative and pragmatic principles. Robert Constanza's (1990) call for permanent colleges, departments, or programs of integrated transdisciplinary studies imagined coexisting alongside traditional disciplinary departments and new fields or meta-disciplines. And, Scholz and Marks (2001) proposed a transdisciplinary college equipped with laboratories where scientists and practitioners could work together for limited periods of time. Actual sites of transdisciplinary learning also include communities of practice, real-world labs, and short-term training and professional development. In the latter case, the US-based National Academies state-of-the-art report on team science distinguished "education" from "training" and "professional development." Education typically consists of didactic presentations and other activities spanning single courses, discipline-based departments, and crossdis-

ciplinary programs. In contrast, training and professional development often occur outside classrooms in formats and settings ranging from hour-long presentations on specific topics to week-long workshops and seminars as well as retreats on aspects of integrative and collaborative research (NASEM 2015). These categories are not absolute, however. Short-term training for students is appearing more often in universities in modules within traditional courses, special workshops and seminars, as well as extra-curricular activities. For faculty it also occurs in ongoing professional development, summer residencies, and research leaves. In addition, research centers and institutes offer formal events, informal speaker series, and journal clubs that are often focused on new areas of research and related methods. Moreover, learning occurs in laboratory research and in the process of participating in team-based projects.

The foregoing scope of examples calls for rethinking the site of learning from static and permanent locations to transaction spaces that are emergent and may change over time. In an address on the nature of knowledge translation, Michael Gibbons (2008) challenged the popular connotation of translating findings from one domain to another as a one-way linear flow. He faulted the image of transfer for minimizing and even outright ignoring how knowledge changes in the process of translation, a long-standing connotation of the term in humanities scholarship and the field of translation studies. Shifting the metaphor of translation from transfer to exchange, Gibbons emphasized, accentuates dialogue. However, in contrast to a prevalent assumption that interdisciplinarity bridges and integrates existing disciplinary approaches with their respective languages, transdisciplinarity transcends and even transgresses them. Implications follow for the nature and extent of dialogue in trans-disciplinary contexts. Transdisciplinarity was associated traditionally with unity of knowledge in a unified discourse. However, it evolved over the 20th century to include new synthetic paradigms with their own discourses and communities of practice, including general systems theory, feminist theory, and subsequently sustainability. Working within their enclaves and using their insights in collaborative projects requires learning their epistemologies, languages, and attendant methods. The more recent connotation of co-production of knowledge by academics and stakeholders also requires learning approaches in multiple sectors, including scholarly, lay, traditional, and Indigenous forms of knowledge, wisdom, and experience. Furthermore, Gibbons added, the number of sites of knowledge production has increased, extending beyond academic trading zones of interaction to wider exchanges across institutional boundaries while reinforcing pressure for the university to fulfill its social mission. To no suprise, then, preparing the next generation of students, faculty, researchers, practitioners, government and industrial personnel, as well as members of communities, has become a prominent topic in literature on cross-disciplinarity. Competencies loom large in this discussion, typically highlighting designated skills and abilities that foster capacity for integration and collaboration. Previous studies of inter- and trans-disciplinary learning have identified a number of leading traits. An expert level of familiarity with a particular discipline is high on all lists of inter- and trans-disciplinary competencies, but the ability to integrate knowledge from multiple sources and to work on teams is equally important.

Clearly, then, there is no magic bullet: no single formula, method, structure, or strategy of universal relevance that ensures successful outcomes. Yet, the ability to think holistically about both intellectual and societal problems is linked increasingly to capacity for systems thinking in individuals and teams. Following Stokols (2018), for sustainability and other complex global challenges in particular, this ability includes identifying multi-layered dimensions of ecological, social, and health problems, in addition to weighing impacts of proposed solutions. Moreover, it entails thinking across micro, meso, and macro levels while, Stokols added, understanding connections of natural, built, sociocultural, and virtual environments as well as their combined impacts over extended periods rather than quick and short-term fixes.

Two of his 4 Ts also come together in transdisciplinary learning: translation and transculturality. Translational collaborations aimed at transforming social and environmental conditions require not only knowledge of particular specialities but processes of integration and collaboration. In addition, they entail normative competence and ethical sensibilities, especially needed when considering consequences of community interventions. And, the fourth T, Stokols asserted, marks an increasing shift from uni- to trans-cultural research not only on a global scale, across nations, but also subcultures within individual countries, including academic, lay, traditional, and Indigenous forms of knowledge.

Attributes of transdisciplinary capacity

Increase in the number and size of teams has made capacity for collaboration a key topic, even though individual inter- and transdisciplinary work still occur. Teamwork is deemed crucial for addressing complex scientific and societal problems that cannot be solved by one disciplinary approach alone. When placing collective communication competence at the heart of interdisciplinary teamwork, Jessica Leigh Thompson emphasized it is not formulaic. Rather, it is dependent on "numerous irrelationships among communicators, contexts, goals, and the participants' abilities to simultaneously be appropriate and effective" (2009, p. 281). Bridging different disciplinary languages and protocols of practice requires flexibility if a shared conception of the goal of a project and an interlanguage for communicating are to emerge. Establishing common ground, mutual trust, and a climate of cooperation rather than competition are also crucial. Michael J. Baker (2015), though, distinguished collaboration from cooperation and coordination. Cooperation and coordination are needed for collaboration, but the latter entails a high degree of joint attention, communication, interaction, mutual engagement, and co-elaboration of knowledge. Major initiatives such as the *Large*   **>**

> **BOX 1: Personal attributes that comprise a transdisciplinary orientation**
> - ■ *core values* conducive to learning about and integrating different disciplinary approaches to complex research and societal problems
> - ■ *beliefs* that integrating diverse conceptual and methodological perspectives is essential for achieving scientific and societal advances
> - ■ *attitudes* favorable toward engaging in integrative scholarship that bridges multiple disciplines and fields
> - ■ *conceptual skills and knowledge* that enable scholars to view complex problems from a multilevel perspective, synthesize disparate disciplinary and philosophical viewpoints, and produce novel insights transcending preexisting theories and methods
> - ■ *behaviors* that enable one to learn about and synthesize concepts and methods from disparate fields and collaborate effectively with fellow scholars and community members in cross-disciplinary teams (Misra et al. 2015, Stokols 2013)
>
> Source: Stokols (2018, table 9.2)

Hadron Collider have put a magnifying glass on large collaboratories focused on scientific challenges. Smaller ones, though, are no less significant, including arctic research stations where an ensemble of international partners share a common interest in addressing problems of climate change, not the least of which are rising sea levels and episodes of severe weather. Other initiatives are also addressing societal problems including migration, disease, and conflict. Regardless of the focus, though, all teams need individuals who are able to synthetize findings from multiple sources, to participate in co-creating a common vocabulary and vision to work together, and to negotiate differences when conflicts arise. More specific to transdisciplinarity, Stokols (2013, 2018) and Misra et al.'s (2015) concept of "transdisciplinary orientation" for teamwork on complex problems is a composite of values, attitudes, beliefs, conceptual skills and knowledge, and beliefs. Box 1 is Stokols' summary of related attributes.

To elaborate, attributes 1 through 3 – values, beliefs, and attitudes – are personal qualities that individuals bring to teamwork, motivating and inclining them to engage in transdisciplinary collaboration. Values are overarching guiding principles that foster participation in projects that cross boundaries: including intellectual curiosity and open-mindedness, respect for others' points of view, an inclusive stance towards unfamiliar or different perspectives, tolerance for uncertainty, and willingness to take risks. Both beliefs and attitudes, Stokols (2018) noted, may also be positive or negative, in the second case especially when reflecting feelings about specific ideas, people, or objects. Attributes 4 and 5 – conceptual skills and knowledge as well as behaviors – facilitate participation. Conceptual skills and knowledge enable viewing problems from multiple perspectives and levels of analysis, to synthesize disparate viewpoints, and to produce novel insights transcending preexisting theories and methods. Yet, they are coupled with behaviors that enable learning about concepts and methods from disparate viewpoints. In addition, literature on inter- and trans-disciplinary learning recognizes reflexivity as a crucial capacity, not only for individual reflection on limitations of their disciplinary viewpoints but also normative values underlying them. In the case of sustainability it also entails values of social justice, in a complex of factors for both academic research and work with partners beyond university walls. The 4 Ts of research today, Stokols added, prepare students to not only work at boundaries of multiple disciplines but also integrate other theories and methods they learn into their own areas of interest. Implications follow, as well for subthemes of teaching and institutionalizing, prefaced by two insights that loom large when talking about new didactic and structural strategies for learning.

From teaching to institutionalizing

Two major insights frame the relationship of teaching and institutionalizing. First, there is no single unique pedagogy for inter- and trans-disciplinary teaching because educators employ a variety of methods that promote students' active engagement in learning that can be tailored for particular contexts. Hence, *the* pedagogy is a composite of approaches. A broad shift, though, has occurred across disciplinary, professional, and inter- and trans-disciplinary contexts: from traditional didactics and established techniques to learning from immersion in an integrative process. Second, teachers are not the only parties involved. In the first instance, in an updated overview of interdisciplinary teaching Deborah DeZure described the plurality of approaches as "productive" and "inclusive pedagogies" (2017, p. 562). High-impact practices include first-year, keystone, and capstone courses, as well as pro-seminars, learning communities, undergraduate research program, and writing-intensive courses. Methods of problem-, discovery-, and inquiry-based learning are also widely endorsed, while aligned closely with collaborative learning in groups. Historical perspective illuminates the second insight. Formal instruction is still a vital part of education, but teaching has become more student-centered, often expressed as a shift from the teacher as a "sage on the stage" to a coach or a "guide on the side." In addition, relational and feminist pedagogies fostering inclusivity have become more prominent in classrooms, along with problem-focused projects and case studies. Hence, there is no single best way of cultivating competencies. The Association of American Colleges and Universities' conception of "integrative learning" further calls attention to multiple forms of boundary crossing: including curricular and co-curricular experiences as well as theory and practice.[1]

In describing transdisciplinary training for team science, Justin Nash (2008) reported the most effective approach combines formal didactics, mentoring, and research experiences. Comparably, Stokols (2018) advocated a robust combination of curricular and mentorship experiences. In all cases, though, anyone in a teaching role needs to be familiar with both content of pertinent specialties and dynamics of integration and collaboration.

---

1 *https://www.aacu.org/resources/integrative-learning*

The former is typically gained in traditional curricula, supplemented by training modules and other forms of professional development to learn new areas and methods. The latter, though, is not typically taught in formal years and institutions of education. Online resources, though, are available. The Association for Interdisciplinary Studies has identified definitions and practices on its *Resources* webpage to *Publications* and *About Interdisciplinarity*.[2] The *International Network for Transdisciplinary Research*'s toolbox for co-producing knowledge is also a guide to resources with profiles of methods. The toolbox is organized into categories of knowledge synthesis and integration, stakeholder engagement, participatory research, research in teams, collaboration among disciplines, design thinking, and impact-oriented research. It includes well-known techniques such as Delphi polling, Venn diagramming, and design thinking, as well as emancipatory boundary critique and multi-stakeholder discussion grouping. It also covers scenario integration, storywall, a give-and-take matrix, an outcome spaces framework, and an approach to functional-dynamic stakeholder involvement.[3] Here too, a variety of strategies promote inter- and trans-disciplinary learning. The second major insight is that teachers are not the only ones responsible for learning.

Educators continue to be primary figures, but researchers also need to be aware of dynamics of integration and collaboration, as well as research administrators and managers. Formal education and professional development for practitioners is crucial as well, including clinicians, government agents, and industrial leaders who call increasingly for ability to work beyond both disciplinary and institutional boundaries. In addition, staff of funding agencies and policy-making bodies need to make good on their own rhetoric of endorsement. And, community stakeholders need to be familiar with the nature of crossdisciplinary and cross-sector work, guided by training within a project or guidance of a project administrator or boundary agent who doubles as a coach. Moreover, for all parties, integration and collaboration are not single moments in the life of a research project or program or designated steps in a linear model of integrative process. They require iteration and ongoing reflexivity. Introducing a new international collection of case studies on *Institutionalizing Interdisciplinarity and Transdisciplinarity,* Klein et al. (2022) affirmed heightened calls for institutionalizing structures and strategies but ackowledged continuing barriers and disincentives shaped by common obstacles as well as local, regional, and national influences. Given the heterogeneity of practices, they did not endorse a single-best structure or strategies. They also treated institutionalizing as a verb, not a static noun associated with buildings, organizational charts, and objectifications of ideas and goals. In doing so, they adopted Davidson and Goldberg's (2009) definition of institutions as mobilizing networks. The metaphor of mobilizing heightens awareness of dynamics of change in institutions.

Institutionalizing

To provide a comparative basis for thinking across a global expanse of countries, Klein et al. (2022) identified five themes the topic of institutionalizing raises:

1. Historical and geographical contexts shape possibilities and limits, including political and economic conditions and developments.
2. Both spatial and temporal dynamics factor into organizational structure, calling attention to dynamics of tradition and change.
3. Not all reforms are equal, ranging from small modifications to integration of alternatives to comprehensive transformation.
4. A robust portfolio of strategies combining strategic targeting and loosening barriers in bottom-up, mid-tier, and top-down efforts.
5. The composite of insights from the first four themes reveals the variety of factors that help or hinder institutionalizing inter- and trans-disciplinarity.

Given that the scope of contexts in the volume is wide – spanning Africa, Europe, Russia and the South Caucuses, Latin America, North America, Australia, and Asia – the authors cautioned against pitfalls of simplistic and universalist transfers of knowledge and practices.

In the aggregate, the collection of case studies on *Institutionalizing* and the larger literatures on inter- and trans-disciplinarity underscore agendas and the efforts they shape differ on a spectrum ranging from resistance to overt activism. Furthermore, adhocracy is more prominent than radical transformation. Barriers and disincentives are not isolated. They reinforce each other in a systemic manner. Organizational structures and standard policies continue to limit flexibility. Funding favors established forms of expertise. Insufficient resources and infrastructure undercut long-term follow-up. And, the academic hierarchy of recognition and reward reinscribes conventional criteria of quality, favors individual achievements, and values fundamental research over commerical and community-based work (Klein 2021). Three final and intertwined debates arise for institutionalizing. What form should efforts take? When should they occur? And, to what degree? Some ideal models are institution-wide, celebrated among them Arizona State University's restructuring around problem-oriented schools and institutes, including sustainability.[4] This model is rare, however. Autonomous units are more numerous. For instance, sustainability is a cross-secting theme in the *Social Ecology* program at the University of California-Irvine.[5] And, a multitude of other units populate the landscape of higher education. Determining formats, timing, and degree of change depends in significant part on context. An institution-wide reform of the kind at Arizona State University will be impossible at many sites. Autonomous programs are also   **>**

2 *https://interdisciplinarystudies.org*
3 *https://transdisciplinarity.ch/en/methoden*

4 *https://schoolofsustainability.asu.edu* and *https://www.asu.edu*
5 *https://socialecology.uci.edu*

often peripheral to the primary mission of their host universities or colleges. And, other enclaves may be small and not reach the campus at large. Yet, making good on exhortations to prioritize grand challenges requires every institution, to use a colloquial expression, to go beyond talking the talk to walking the walk. Failing to do so perpetuates the gap between rhetoric and reality.

References

Baker, M. J. 2015. Collaboration in collaborative learning. *Interaction Studies* 16/3: 451–473. https://doi.org/10.1075/is.16.3.05bak.

Costanza, R. 1990. Escaping the overspecialization trap. In: *Rethinking the curriculum.* Edited by M. E. Clark, M. E. Wawrytko, S. A. Wawrytko. New York: Greenwood. 95–106.

Davidson, C. N., D. T. Goldberg. 2010. *The future of thinking.* London: MIT Press. https://doi.org/10.7551/mitpress/8601.001.0001.

DeZure, D. 2017. Interdisciplinary pedagogies in higher education. In: *The Oxford handbook of interdisciplinarity.* Edited by R. Frodeman, J. T. Klein, R. Pacheco. Oxford, UK: Oxford University Press. 555–572. https://doi.org/10.1093/oxfordhb/9780198733522.013.45.

Gibbons, M. 2008. Why is knowledge translation important? Grounding the conversation. *FOCUS Technical Brief* 21: 1–9.

Jantsch, E. 1972. Inter- and transdisciplinary university: A systems approach to education and innovation. *Higher Education* 1/1: 7–37. https://doi.org/10.1007/BF01956879.

Klein, J. T. 2021. *Beyond interdisciplinarity: Boundary work, communication, and collaboration.* Oxford, UK: Oxford University Press. https://doi.org/10.1093/oso/9780197571149.001.0001.

Klein, J. T., B. Vienni-Baptista, D. Streck. 2022. Institutionalizing interdisciplinarity and transdisciplinarity: Cultures and communities, timeframes and spaces. In: *Institutionalizing interdisciplinarity and transdisciplinarity: Collaboration across cultures and communities.* Edited by B. Vienni-Baptista, J. T. Klein. London: Routledge. 1–9. https://doi.org/10.4324/9781003129424.

Misra, S., D. Stokols, L. Cheng. 2015. The transdisciplinary orientation scale. *Journal of Translational Medicine and Epidemiology* 3/2: 1042.

NASEM (National Academies of Science, Engineering, and Medicine). 2015. *Enhancing the effectiveness of team science.* Washington, D.C.: National Academies Press.

Nash, J. 2008. Transdisciplinary training. *American Journal of Preventive Medicine* 35/2S: S133–S140. https://doi.org/10.1016/j.amepre.2008.05.004.

Scholz, R., D. Marks. 2001. Learning about transdisciplinarity. In: *Transdisciplinarity: Joint problem solving among science, technology, and society.* Edited by J. T. Klein et al. Basel: Birkhäuser. 56–81.

Stokols, D. 2018. *Social ecology in the digital age: Solving complex problems in a globalized world.* London: Academic Press.

Stokols, D. 2013. Training the next generation of transdisciplinarians. In: *Enhancing communication and collaborations in interdisciplinary research.* Edited by M. O'Rourke et al. Los Angeles: Sage. 56–81. https://doi.org/10.4135/9781483352947.n4

Thompson, J. L. 2009. Building collective communication competence in interdisciplinary research teams. *Journal of Applied Communication Research* 37/3: 278–297. https://doi.org/10.1080/00909880903025911.

A tribute to *Julie Thompson Klein* can be found in the obituary (in this issue, pp. 84 f.).

GAIA Masters Student Paper Award

The international journal GAIA – Ecological Perspectives for Science and Society invites Masters students to participate in the 2023 GAIA Masters Student Paper Award.

Masters students are encouraged to submit their results from research-based courses or from Masters theses in the field of transdisciplinary environmental and sustainability science.

Submission guidelines and more information:
www.oekom.de/zeitschriften/gaia/student-paper-award
Deadline for submission: November 27, 2023.

The winner will be selected by an international jury and will be granted a prize money of EUR 1,500 endowed by the Selbach Umwelt Stiftung and Dialogik gGmbH, as well as a free one-year subscription to GAIA, including free online access. The winner may also be encouraged to submit his or her paper for publication in GAIA.

DIALOGIK
gemeinnützige Gesellschaft für Kommunikations-
und Kooperationsforschung mbH

Selbach Umwelt Stiftung

GAiA