

Transdeep learning in higher education: Institutionalising transdisciplinarity

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Abstract

This think piece was serendipitous. While investigating deep learning and transdisciplinary learning for another paper, a Google Scholar search using *transdisciplinary deep learning* generated zero results. *Transdisciplinary, deep learning* yielded nominal results. Neither term was defined or elaborated. This unexpected outcome prompted an intellectual exploration of the import of the comma. We deduced that it matters, coined the neologism *transdeep learning* and speculated about its conceptualisation. Our thoughts (findings per se) may shape how (if) universities institutionalise transdisciplinarity in their modus operandi. We recommend strategically, sequentially, institutionalising deep learning, then transdisciplinary learning followed by transdisciplinary, deep learning; and, ultimately, transdeep learning. We offer transdeep learning as an avant-garde, next-level construct that can inform higher education's strategic planning, academic infrastructure, curricular development, pedagogy, and research within and outside the academy via ties with industry, government, and civil society.

KEYWORDS

deep learning, higher education, transdeep learning, transdisciplinary deep learning, transdisciplinary learning

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The Microsoft Editor Score is 93% (reflects foreign name spellings). The *similarity-to-online-source* score is 7% (below acceptable range of 15%–20%), the *Flesch reading ease* score is 15.3 (recommended for topic experts and academic papers), the *Flesch–Kincaid grade score* is 14.3 (advanced college) and the *passive voice score* is 8.7% (within preferred 10% limit).

INTRODUCTION

Humanity is facing compelling issues – grand-scale problems: unsustainability, climate change, biodiversity loss, health pandemics, violence, wars, and uneven income and wealth distribution leading to polarised haves and have nots. These are wicked and deeply complex problems (Shrivastava & Zsolnai, 2025). Wicked connotes fearful, intolerably bad, and distressingly severe. Complex signifies more than complicated or difficult. It means interconnected, interwoven, and intertwined – both inherently and by design (McGregor, 2020b; Morales, 2017).

The new-science (e.g., chaos theory, quantum physics, and complex adaptive systems) understanding of these popular terms (wicked and complex) opens the door for a discussion of how higher education curricula and institutional arrangements must change to accommodate them vis-à-vis transdisciplinarity (TD). Indeed, Montuori (2023) claimed that because siloed higher education prepares hyper-specialised students who are ill-equipped to face complexity, ‘there is an emerging interest in ... transdisciplinary education’ (p. 161).

Transdisciplinary higher education is a complex endeavour requiring adaptations to educational approaches and goals whose success depends on establishing institutional environments and attendant curricula for transdisciplinary learning (Shrivastava & Zsolnai, 2025; Vilsmaier & Fritz, 2024). This think piece about institutionalising transdisciplinarity in higher education was grounded in two premises. First, learning how to recognise, work through, and accommodate complexity requires curricula that ensure *deep learning* (McGregor, 2022). For our purposes, deep learning does not refer to the machine-learning (ML) model or to artificial intelligence (AI) that simulates how humans gain knowledge (Benois-Pineau et al., 2023). Second, teaching about complexity is enhanced with *transdisciplinary learning* and transdisciplinary perspectives (McGregor, 2022).

With this in mind, we academically explored how deep learning and transdisciplinary learning play out (separately and together) in higher education when used to address complex, wicked problems. As intellectual contributions, think pieces are deemed ‘legitimate and important forms of [scholarly] discourse’ (Kennedy, 2007, p. 139). They contain conceptually advanced but still evolving views shared to engage and challenge current thinking. The anticipated outcome is provocative dialogue and discourse that may prompt intellectual and pragmatic innovations. They serve as valid ‘tools for contributing to the cumulative improvement of theoretical knowledge’ (McGregor, 2018, p. 470). No empirical research is required nor expected to generate a think piece; hence, readers should not expect to find methods, results, or discussion sections in this paper (McGregor, 2018; McLean, 2011).

INTRODUCING THE TRANSDEEP LEARNING NEOLOGISM

The literature reviewed was about either (a) deep learning (e.g., Fullan & Langworthy, 2013; McGregor, 2020a; Tochon, 2010; Warburton, 2003); or (b) transdisciplinary learning (e.g., McGregor, 2015, 2022; Mishra et al., 2011; Müller et al., 2005). In the nascent literature that combined them, researchers tended to use a comma (e.g., transdisciplinary, deep learning), which grammatically intimates two different items in a series describing learning. This serendipitous finding created a space to consider *transdisciplinary deep learning* (without a comma) as something different as well – a fourth approach that differs from its derivative sister constructs and its associate with a comma. To capture its essence, we introduced the neologism *transdeep learning* and explored whether the comma changes the nature of learning. Is the neologism warranted?

As evidence of the neologism's novelty, an initial March 2023 Google Scholar search for the exact term ‘transdisciplinary deep learning’ yielded zero results. A September 2024

follow-up search 18 months later revealed two results as did a March 2025 search six months after that. Chen (2023) said she had built an ‘innovative transdisciplinary deep learning model’ (p. 98), but she never referred to the term again. After tendering a ‘diagram of transdisciplinary deep learning,’ Listengarten and Watson (2023, p. 7) did not use the term again either. Google Scholar search results for ‘transdisciplinary, deep learning’ (with a comma) were similarly limited over the same two-year period. Fiorini and De Giacomo (2017, p. 491) referred to ‘a transdisciplinary, deep learning approach’ but did not define it. Äerdschëff Regenerative and Circular Science (2020, para. 1) claimed it ‘aims to develop transdisciplinary, deep learning contexts’ but did not elaborate.

There was negligible scholarship using transdisciplinary deep learning and none using the transdeep learning neologism (as of April 30, 2025). Regarding the former, Listengarten and Watson created a Venn diagram comprising four concentric circles (encompassing intentional, empowering, reflective and engaging) and placed ‘transdisciplinary deep learning’ at their interface. The two key contributors were students and disciplines on the vertical axis, and faculty and community on the horizontal axis with arrows from each pointing toward the transdisciplinary deep learning centre. This type of learning happens with (a) rich, student-centred learning experiences; (b) contributors’ cooperation and collaboration; (c) deep interaction and engagement with various stakeholders’ viewpoints; and (d) the ‘co-production of new “forms of knowledge” inspiring transformative actions’ (2023, p. 6).

The contributions of this think piece should enrich the ongoing global institutionalisation of transdisciplinarity in higher education with the intent of entrenching it within the academic system in such a way that it can thrive and be sustained (Vienni-Baptista & Klein, 2022). Hand in hand with institutionalising transdisciplinarity in higher education is the emergent vision of a *transversity* to augment traditional universities. A transversity would seek *trans-truths* (i.e., complex, integrated knowledge) (instead of one truth – university) by moving back and forth between and among disciplines and beyond the academy to include government, industry, and civil society (Darbellay, 2024; McGregor, 2024; McGregor & Volckmann, 2011). ‘Transversity curricula would be predicated on deep learning and deep education [and] be designed with the intent to foster transdisciplinary learning cycles and create transdisciplinary mind habits’ (McGregor, 2024, p. 596).

LITERATURE REVIEW

To explore how deep learning and transdisciplinary learning separately play out in higher education, we distinguished deep learning from its sister approaches, surface and shallow learning, and provided an overview of transdisciplinary learning.

Surface, shallow, and deep learning

Surface learning

Per Table 1, people just *scratch the surface* (the outermost layer) with surface learning. They superficially engage with content and issues and only initiate the briefest (if any) investigation to discover hidden concerns or meanings. They do a small amount of learning activity but not enough to understand or solve things. With this minimal effort, people tend to make minimal progress. They learn facts and bits of information but have no opportunity or inclination to extend or apply that learning. They learn what is required but nothing more. There is little to no personal engagement with the material, and they do not come away with

TABLE 1 Comparison of surface, shallow, and deep learning (extrapolated from McGregor, 2020a).

Surface learning	Shallow learning	Deep learning
• broad knowledge but no depth (lacks detail) • based on awareness of a situation/fact in combination with passive, uncritical reception of information • depends on memorisation (rote learning) • little meaning-making happens (low understanding and insight) • no conceptual connections (fragmented bits of information) • fail to build on previous learnings • can only <i>scratch the surface</i> of complex issues	• in the shallows, learning is superficial (not thorough) and trivial (marginal or insignificant) • learn to problem-solve but are unable or have no chance to bring intellect and serious thought to bear • any knowledge gained is not tied to central concepts, making it hard to acquire theoretical and abstract understandings • learning is not very critical; tend to focus on symptoms of an issue instead of the underlying causes – political, cultural, or ideological	• learn self-reflection and examine one's belief system and value set; question one's basic principles • with this insight, learning becomes very critical in nature (reveals power); go deep to see patterns, analyse, draw on synergy, and then make connections (connect the dots) • explore and discover details about an issue, and then present a position or argument while anticipating resistance • handle concrete information as well as deeper, higher levels of abstraction (ideas) • gain inner power and confidence to self-direct own learning – deep learning releases human potential (self-power)

an appreciation for guiding principles – just facts. Surface learning involves a very teacher-centred, sage-on-the-stage pedagogy (Bennet & Bennet, 2008; Khillar, 2020).

Shallow learning

Learning in the shallows is better than being stuck on the surface, as the shallows have at least some depth. When it comes to learning, however, shallowness means people do not engage in serious thought – either because they cannot or are not required to do so. People's understanding of complex issues is, thus, very limited (Bennet & Bennet, 2008; Stibbe, 2004; Willingham, 2009). 'Shallow learning leads to shallow knowledge that is not connected to central concepts. Often, those concepts are trivialised or presented as nonproblematic' (McGregor, 2020a, p. 9). It is also passive; people receive information without engaging with it. Information retained and memorised fades quickly from memory (Marton & Säljö, 1976; Zheng, 2020). This 'learning loss' triggers underachievement in academics and life because what was taught was not learned (Smith, 2017, para. 2).

Deep learning

Deep learning happens when people delve far below the surface and the shallows and start making connections (Marton & Säljö, 1976). This added depth helps them engage with complexity via profundity of thought. Critically penetrating engagement with issues exposes the underlying causes and power dynamics, which are usually ideological and manifest in political, economic, social, and environmental issues and challenges. Drawing on critical insights, people connect the dots by associating disparate ideas leading to a penetrating impression of the big picture. This is possible when they discern salient, critical insights buried within a mass of data (Manville, 2015). With educators' assistance, learners *dig deep* to 'find the seeds from which new patterns develop' (Fullan & Langworthy, 2013, p. 1). Connecting the dots reveals the patterns. New seeds of thought take root and flourish, leading to innovative ideas pursuant to addressing the wickedness of complex, grand-scale problems (Manville, 2015). McGregor (2020a) explained deep learning thus:

deep learning [is] predicated on the construct of *depth* versus shallowness. Depth refers to complexity and profundity of thought (penetrating deeply), incredible intensity (concentration and passion) and comprehensiveness of study (Anderson, 2014). Deep learning also entails understanding and questioning basic principles, exploring things in great detail, and putting forward an argument while expecting resistance and push back. It involves self-reflection and examining one's beliefs and value system. (p. 9)

Six Cs of deep learning

Fullan (2013) identified six deep-learning goals or outcomes (6Cs): citizenship, character education, creative thinking and imagination, communication, collaboration, and critical thinking and problem-solving. As a caution, students must 'master all of them – miss any one or two and the entire edifice is fundamentally weakened' (Fullan & Scott, 2014, p. 3).

Once mastered, students appreciate the importance of and how to (a) understand diverse values, (b) work synergistically and interdependently with others to address complex problems and (c) engage and communicate effectively with a range of actors and audiences. (d) Students will have tenacity and perseverance (character traits). They (e) will know how to see patterns and connections and how to apply these insights in the real world. And (f) they will hone a creative eye, learn to critically pose the right questions, and generate novel ideas (Fullan, 2013; Fullan & Scott, 2014).

These 6Cs can best be achieved when learners and educators are proactive learning partners –teachers are facilitators and guides, and students self-direct and control their learning (Fullan, 2013). They have a better chance of learning deeply if they intentionally seek to understand and look for meaning, engage with, operate in, and value the topic they are studying (Danker, 2015). Deep learning 'will draw new energy that will expand geometrically as it feeds on itself' (Fullan, 2013, p. 26). The best evidence of success is the ability to transfer knowledge, skills, and attitudes to new contexts beyond where they were originally learned. Transferability enables graduates to apply deep learnings when facing divergent changes and challenges (Budwig & Alexander, 2020; Fullan & Scott, 2014; Mthethwa-Kunene et al., 2022).

Deep learning mindset

University educators are, thus, encouraged to help students build an academic mindset conducive to creating exponential deep learning energy and internalising the transferable 6Cs. This habitual way of thinking enables self-directed and self-regulated learning. (a) Students begin by internalising relatively simple concepts, constructs and ideas. (b) Once part of their knowledge base, they draw on them as they process more and different facts, insights, and impressions. (c) This iterative process leads to deeper and deeper levels of abstraction, until they can internalise very complex ideas. (d) Foremost, they become less dependent on others to help them interpret issues, leaning instead on their own framework of mental acuity (Briceño, 2013; Briggs, 2015; Budwig & Alexander, 2020; LeCun et al., 2015).

Deep knowledge is thereby created when an array of disparate sources is 'united and transformed into something new, which then cannot be reduced back to old knowledge. [It is] created by merging fundamental disciplinary knowledge with knowledge from the lived world. Deep knowledge comprises underlying meanings and principles integrated with previously existing facts and feelings' (McGregor, 2017, p. 6).

Deep learning cycle

The deep learning cycle comprises learning, doing, knowing, adapting, inventing and living (Fullan & Scott, 2014). Upon successfully completing this six-stage cycle, 'action, reflection, learning and living can now become one and the same' (p. 3) – they are indistinguishable. It is not easy to discern among them because they blur together and become less perceptible separate stages. In effect, learning and life become seamless – cannot tell where one stops and the other begins. Learning becomes continuous and progressively less difficult and problematic as life unfolds. Deep learners are '*change implementation savvy* (being able to engage others in constructive change and make it happen); *inventive* (being able to create new artefacts, processes) ...; and *clear on where [they] stand* on contestable tacit assumptions' (Fullan & Scott, 2014, pp. 3–4).

Altbergs and Gagnon (2017) proposed a five-stage deep learning cycle. (a) In the *meaning making* stage, students become convinced that what they are expected to learn will have meaning in their life, thereby inspiring them to engage further. (b) In the *investigation* stage, they ask important questions (eventually the right question), conduct research, analyse, and formulate a new idea and frame a new problem to explore. (c) Through *synthesis*, they strive for new connections and insights, which they use to (d) *create or design* a product or service and (e) *communicate* to the intended audience, and they *reflect* on the process. With repeated exposure to this cycle, they become 'naturally capable and competent under all conditions [and can] count on themselves in a complex and uncertain world, and help others to do so' (p. 8).

Deep education and deep teaching

To ensure that deep learning can happen, and that deep knowledge can emerge, higher education must foster and facilitate deep education (Chan et al., 2014). It concerns (a) the whole person; (b) a deep sense of human identity; and (c) it involves a reconceptualisation of how people view their reality as students learn how to employ deep processing, so they can connect the dots (Tochon, 2010).

Deep learning also depends on learner-centred deep teaching. While teacher-directed surface and shallow teaching cover official curricula, deep teaching better ensures that what is taught is meaningful for learners and meets their life goals and issues. Depth and relevance are more important than coverage. Deep knowledge is gained through self-reflection and reflexivity or self-awareness of biases, prejudices and assumptions. With deep teaching, students engage in 'world-view reframing [through] individual and group work on actual, real-life situations and real-world problems. [Deep teaching] integrates ethics, is politically active and aims toward social justice [via] cross cultural collaboration' (Tochon, 2010, p. 6).

As deep education and deep teaching both 'explain and address current stakes [whose resolution require] a deep transformation of humans and human society' (Tochon, 2010, p. 5), universities should engage in 'the quest for a deeper sense of humanity and humanness' (p. 3). This deep connection with humanity is a transdisciplinary learning imperative (Nicolescu, 2005).

Transdisciplinary learning

Transdisciplinary learning is an 'exploration of a relevant issue or problem that integrates perspectives of multiple disciplines [and sectors to] connect new knowledge and deeper understanding to real life experiences' (Kompar as cited in McGregor, 2017, p. 6). It has four key features. (a) What is learned relates to socially relevant issues. (b) The learning

transcends disciplinary boundaries and paradigms and integrates them. (c) People living with the problem participate in the learning process. (d) And learners are engaged in a deep search that leads to the unity of knowledge (Pohl, 2011).

As with deep learning (Bennet & Bennet, 2008; McGregor, 2020a), transdisciplinary learning requires less reliance on disciplinary concepts and frameworks and more on creating one's own intellectual framework to interpret the problem (Müller et al., 2005). But, *unlike* deep learning, with transdisciplinary learning, that intellectual framework is mutually created *with* diverse others (Derry & Fischer, 2005). Curricula thus ensure that students engage with multiple stakeholders (McGregor, 2019). To wit, transdisciplinary learning does not happen in isolation.

Instead, students learn collaboratively *with others* (e.g., students, faculty, disciplines, and actors beyond the university) while concurrently really listening and talking to each other. Their ultimate work is highly integrated and informed by each person's evolving interpretive intellectual framework as well as a common, shared intellectual framework emergent from their interactions (Derry & Fischer, 2005; McGregor, 2019; Park & Son, 2010; Wall & Shankar, 2008). In effect, they 'become a community of learners working for a common cause rather than just a collection of people' (McGregor, 2020a, p. 8).

Transdisciplinary knowledge

Transdisciplinary knowledge, which arises from transdisciplinary learning, is complex, emergent, embodied and cross-fertilised (Nicolescu, 2002).¹ Respectively, it is *complex* because those involved creatively used leverage as they reorganised themselves and self-adapted while acting without external control. They trusted that something useful would *emerge*. In other words, they viewed TD knowledge as always becoming, changing and evolving instead of being fixed and static – it is alive, 'in vivo knowledge'. It is *embodied* or part of everyone who cocreated it rather than being person-, discipline- or sector-bound. It is *cross-fertilised*; an exchange of diverse ideas and information from several sources stimulated its development to increase the range of variability available to produce an agreed-to outcome (McGregor, 2015; Nicolescu, 2002, 2014).

The creation of TD knowledge to effectively address complex, wicked problems requires boundary spanning, interactions in the fertile included middle zone (of nonresistance to others' ideas) and intellectual borderwork at a deep, deep level (Nicolescu, 2002, 2014). Students learn (a) how to interact with, among, and beyond disciplines and the academy, with industry, government, and civil society; (b) that problem-posing and -solving happen far beyond university borders in an arena rife with challenges but ripe with potential (Latin *potentia*, 'power'); (c) that they are knowledge producers and creators – much more than knowledge consumers; and (d) that they are accountable to both their university learning experience and wider society (McGregor, 2022).

Transdisciplinary mind habits

Mishra et al. (2011) proposed that people who are adept at creatively thinking across a range of domains and sectors to integrate different perspectives and viewpoints tend to draw on a unique set of cognitive skills that they called transdisciplinary mind habits. These inform reasoning and comprise perceiving, patterning, abstracting, embodied thinking, modelling, deep playing, and synthesising (see Figure 1) (see also Mishra & Koehler, 2006). Mishra et al. (2011) believed that honing these mental tools and making these mind habits available for reasoning better ensures that 'students can learn the true nature of any domain, and

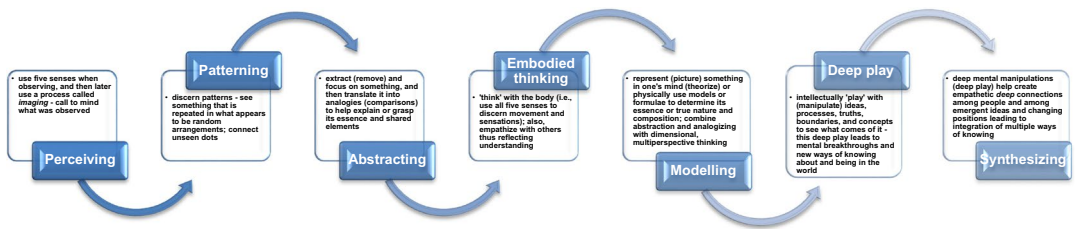


FIGURE 1 Seven transdisciplinary mind habits.

through that have the potential to be transformed in how they learn, how they view themselves, and their possible futures' (p. 25). Learning these mind habits provides the wherewithal to think through the process of integrating perspectives to cocreate transdisciplinary knowledge.

Derry and Fischer's (2005) approach to a transdisciplinary mindset was anchored in community. (a) To come together and cross boundaries, people must create or bring boundary objects or artefacts that enable connections: ideas (concepts and constructs), standards, products, models, theories, procedures and designs. Their usage helps diverse ideas become more comprehensible to the varied people involved. (b) Everyone must have a sustained commitment to mutual learning and collaboration, which enables them to build a knowledge-creation community. (c) And everyone must be predisposed to metacognition – thinking about their own thought processes. The result is a reflective knowledge creation community that can work through differences and distances whether geographic, ideological, conceptual, philosophical, theoretical, social, cultural or political.

Transdisciplinary learning cycle

Müller et al. (2005) conceptualised a transdisciplinary learning cycle based on three stages: creative/design, descriptive/research, and normative/deliberation. Learning occurs through continuous interactions between internal interpretations and external actions. In short, 'an object created from the *design* phase is used as input for the *research* phase whose meaning is then *deliberated* by all actors party to the learning process. This process entails individual as well as group learning, such that new TD knowledge emerges from iterative border work' (McGregor, 2014, p. 4).

By border work, McGregor (2014) meant the fertile intellectual space (middle ground) where diverse minds gather with open minds to fuse things into a new whole. She described Müller et al.'s (2005) transdisciplinary learning cycle thus:

First, each participant comes to the table with his or her own purpose, concepts, knowledge and interpretations of the world. Second, informed by their internal perspectives, each participant poses actions, which have a series of expected and unexpected effects. Third, these actions and consequences are observed and described by each participant, leading to a convergence of viewpoints inspiring the creation of new knowledge, ideas and concepts. Each participant's interpretation of these shared data (including boundary judgements), their view of the problem, their chosen approach, and possible solutions might shift, which could lead to new ideas and concepts, and the TD learning cycle continues. (McGregor, 2014, p. 5)

INSTITUTIONALISING 'TRANSDISCIPLINARY, DEEP LEARNING' IN HIGHER EDUCATION

The first part of this paper differentiated between deep learning and transdisciplinary learning as they might manifest separately in higher education. This section explores transdisciplinary, deep learning (with a comma) in university settings. Universities are best positioned for 'addressing the biggest questions of our time and in doing so serving humanity' (Jalbout, 2019, last para.). Transdisciplinary education serves that purpose (Nicolescu, 2005). That said, 'very few universities have attempted to develop a universal undergraduate curriculum organised around expertise in transdisciplinary problem-solving' (Bammer et al., 2023, p. 2; see also Budwig & Alexander, 2020; Cervantes et al., 2018).

Byrne et al. (2016) concurred, claiming that transdisciplinary higher education initiatives are 'to date sadly generally absent, [but] there exist *loci* of alternative practices' (p. 211). To illustrate, Cervantes et al. (2018) recounted the University of Veracruz's (Mexico) experience with trying to transform the university to transdisciplinarity (since 2008). Their driving question was 'How do we generate an authentic university community where all types of borders, be they geographical, disciplinary, or, much less epistemological, cease to exist' (p. 257). Vienni-Baptista and Klein (2022) shared cases of several university's burgeoning experiences with institutionalising transdisciplinarity.

The University of Technology Sydney (2024) has institutionalised transdisciplinary electives on a university-wide scale. The Australian National University (ANU) introduced a universal undergraduate requirement that graduates must leave knowing how to employ discipline-based knowledge in transdisciplinary problem-solving. The curriculum now includes 'disciplinary depth and transdisciplinary breadth' (ANU, 2024, p. 2; see Bammer et al., 2023). However, although graduates will gain transdisciplinary problem-solving skills, this falls short of learning transdisciplinary deep knowledge.

In the absence of concrete examples of transdisciplinary deep learning (transdeep learning) in higher education, this section profiles two well-established and highly regarded universities intentionally striving to institutionalise transdisciplinary, deep learning – one in the United States (Arizona State University) (ASU) and another in Europe (Leuphana University). Profiling these two sites is justified. Shrivastava and Zsolnai (2025) commented on 'several notable attempts at structural transformation toward transdisciplinary thinking, action and engagement at universities, such as Leuphana University in Germany and Arizona State University' (p. 9). While discussing the transdisciplinary approach to deep learning in university settings, Budwig and Alexander (2020, p. 10) noted the 'different approaches in the United States and within European countries.'

As a caveat, in lieu of primary data via researcher-generated case studies, ASU and Leuphana were profiled using public information shared by respective institutions, involved faculty members, and related initiatives. Their self-expressed narratives and experiences (i.e., in situ knowledge) served to illustrate the principles of both deep learning and transdisciplinary learning in action and aided in our contemplation of transdeep learning in higher education. Each university has a culture. Transdisciplinarity respects culturally grounded, in situ knowledge as a valuable source in its own right (McGregor & Volckmann, 2011; Nicolescu, 2014).

As a further caveat, we intentionally profiled two initiatives that focused on institutionalising transdisciplinarity across the entire university rather than within specific colleges, faculties, or degree programmes. Although 'university-wide initiatives are particularly important' (Bammer et al., 2023, p. 1), nascent literature exists about their establishment and success (Bammer et al., 2023; McGregor & Volckmann, 2011; Shrivastava & Zsolnai, 2025; Vilsmaier & Fritz, 2024). This think piece addressed that lacuna.

Arizona state university

ASU is a beacon of transdisciplinary, deep learning. Under President Michael Crow's stewardship (2002–ongoing) (Dabar & Crow, 2015), ASU is driven by its transdisciplinary imperative to augment 'the relationship between the university and the rest of society, civic and corporate' (McGregor & Volckmann, 2011, p. 23). To that end, ASU assumes all students have the innate ability for a transdisciplinary mode of thinking. 'The university's role is to create an environment where they can be comfortable, even excited, to go beyond what they are familiar with and move across other disciplinary boundaries' (McGregor & Volckmann, 2011, p. 45). They confront the 'perfect knowledge paradox [wherein] understanding why [they] cannot understand, [they] begin to understand. ... Only when [they] understand the reasons why [they] cannot achieve real knowledge, [does] it become accessible' (Fiorini, 2018, p. 136).

ASU embraces transdisciplinarity by employing eight guiding principles, one of which is *fusing intellectual disciplines* through transcendence. Transdisciplinary knowledge creation happens when students move to a new space to synthesise and create intellectual fusion. ASU knowledge creation involves transcending academic disciplines and including civil society, industry, and government (ASU, 2022; Crow & Dabar, 2020). The resultant intellectual fusion is the true hallmark of transdisciplinarity (Nicolescu, 2002, 2014).

Another relevant ASU principle is enabling student success by orienting them to the merits of transdisciplinarity via transdisciplinary programmes of study (ASU, 2022). Each student is deemed unique, but *all* are presumed to have the 'innate intellectual potential' to think like a transdisciplinarian using TD mind habits (McGregor & Volckmann, 2011, p. 29; see also Morales, 2017).

To illustrate, ASU's *InnovationSpace*, a transdisciplinary education and research laboratory, ensured deep learning by using an array of relevant instructional strategies in a student-centred pedagogy: Myers-Briggs Type Indicator assessment, team-building exercises, disciplinary knowledge-sharing assignments, project-review sessions, and scaffolded manoeuvring through complex projects with attendant collaborative thinking and interactions. Students further engaged in the formal curriculum, field research, brainstorming, visualisation exercises, and creative and lateral thinking. They also interfaced and interacted with invited guest lecturers from industry, government, and civil society (Selin & Boradkar, 2010).

ASU students are 'guided through a process in which they identify pressing social needs and thoroughly analyse the technological, economic, social and environmental implications of their design solutions' (Selin & Boradkar, 2010, p. 4). This pedagogy inspires deep learning (McGregor, 2017, 2020a), whereby students pursue their own vision, build mutual learning relationships, and strengthen their decisional capital (Fullan & Langworthy, 2013). The self-reliance inherent in transdisciplinary, deep learning and related projects helps students construct their own understanding of a problem (i.e., an intellectual framework) instead of relying on others' interpretation (Bennet & Bennet, 2008).

Dabar and Crow (2015) described ASU as a decentralised 'federation of unique transdisciplinary departments, centres, institutes, schools and colleges ... and a deliberate and complementary clustering of programmes arrayed across four differentiated campuses' (p. 246). Indeed, 'ASU, historically, has pushed the boundaries and disrupted the higher education landscape by reshaping what education should look like, how it's accessed and how students are empowered to succeed' (ASU Newsroom, 2022, para. 6).

For ten years running, ASU has been the number one, most innovative American university out of a possible 4000. The National Science Foundation rated ASU number one in transdisciplinary science in 2023 (Faller, 2024). In 2019, ASU was in 'the top one percent of the world's most innovative prestigious universities' (Garcia, 2019, p. 127). In 2024, it ranked as the second most innovative university in the world (World University

Rankings for Innovation, 2024). Its sustained commitment to transdisciplinary, deep learning helps it attain these rankings. By design, ASU students engage in deep learning via transdisciplinary programmes of study replete with (a) an immersive culture; (b) learning embedded in perpetually improved, innovative curricula; and (c) exposure to a forward-thinking mindset.

Leuphana university

Leuphana University (Lüneburg, Germany) is one of four founding partners of the prestigious *tdAcademy* (<https://td-academy.org>), which conducts, promotes, and shapes transdisciplinary research in Europe. Beyond lifelong learning competencies, the *tdAcademy* strives for 'a genuine mutual learning process between all actors involved, community building and the provision of spaces for the exploration of interfaces and new ideas' (Barth et al., 2020, p. 197). The intent is to augment capacity building to empower change agents who can effectively address complex, wicked problems (Barth et al., 2020). Within this European context, Leuphana University's

multi-award-winning [transdisciplinary] study model ... is still unique in Germany. ... It goes beyond the boundaries of a purely subject-specific course of study [and combines this] with specialist knowledge. [Students learn] to deal with complex (i.e., socio-ecological) scientific problems beyond previous thinking without bias by learning to reflect on their own subjects from the perspective of others. [They are introduced] to cross-border cooperation between several fields of science and/or actors outside the academy with a transdisciplinary perspective. The focus here is on raising awareness of disciplinary boundaries, gaps between different knowledge domains, and transition zones, and their epistemological and politically legitimising implications. (Adomßent, 2022, pp. 27–28)

Leuphana University (2025b, para. 4) advertises that it offers transdisciplinary learning that involves 'collaboration between the representatives of different university subjects [disciplines] and with actors from outside the university, e.g., from politics, culture, NGOs or business.' This holistic understanding of what constitutes transdisciplinary learning intimates a respect for deep learning, although this term was not used in their rhetoric.

That said, evidence of deep learning exists and includes the university's intention for all students to experience (a) critical reflection, (b) a diversity of perspectives (c) and respect for and identity with stakeholders' cultures. (d) The university also respects that transdisciplinary learning requires a greater time investment than surface or shallow learning, in conjunction with a pedagogy that accommodates "soft" or cultural characteristics' (Leuphana University, 2025b, para. 9). The latter include interactions, communication, critical discourse, and acknowledging and accommodating expectations (Leuphana University, 2025b) – aspects of the 6Cs of deep learning (Fullan, 2013).

To gauge how well the transdisciplinary learning approach was working and how it was understood to work by the involved Leuphana faculties, Vienni-Baptista (2018) conducted a survey of 2017–2018 educational offerings ($N=27$ transdisciplinary courses and seminars) and interviewed $N=39$ involved faculty members representing all four faculties at the time. Two definitions of transdisciplinarity were reported. Some faculties related it to the 'participation of other actors or stakeholders in research projects' (p. 1). Others viewed it 'as the possibility of transcending disciplines and building a new perspective on a problem with no disciplinary boundaries' (p. 1). Respectively, transdisciplinarity was seen as either (a) research-related involving nonacademic actors or (b) problem-related beyond the academy.

Although 'co-teaching and the application of innovative didactic strategies are the basis for all [Leuphana transdisciplinary] seminars and courses, [reported pedagogical strategies ran the gambit from] traditional lectures to campaign design and work in local orchards' (Vienni-Baptista, 2018, p. 2). Not all Leuphana students may have benefited from transdisciplinary, deep learning despite being expected to 'perform different learning processes' (Vienni-Baptista, 2018, p. 2). Transdisciplinary learning is about opening students' minds to the idea that learning can happen beyond disciplines (Vereijken et al., 2023).

Participating in transdisciplinary teaching generated 'real enthusiasm among academics' (Vienni-Baptista, 2018, p. 2) who recognised the necessity of 'building strong relationships with stakeholders and other actors outside academia [along with] group formation skills and conflict management' (Vienni-Baptista, 2018, p. 2). Faculty-articulated challenges related to (a) transdisciplinary teaching and learning, (b) with administration and (c) at the institutional level. While acknowledging the relevance of integration in their teaching process, faculty held students 'responsible for integrating the contents of the course' (Vienni-Baptista, 2018, p. 2). Nominal faculty acknowledged the importance of fostering intercultural skills, collaboration and communication to ensure integration.

Evaluation of student learning was a weak link in Leuphana University's transdisciplinary teaching and learning experience. Virtually all courses (90%) used essays and oral presentations (Vienni-Baptista, 2018) instead of recommended deep learning evaluation strategies such as projects, portfolios, design innovations, and community engagement (see Selin & Boradkar, 2010). Leuphana students may have lacked opportunities to fully engage with a transdisciplinary, deep learning pedagogy, especially if problem-solving, thinking creatively, innovating, and character and citizenship development were excluded or minimised (Fullan, 2013; Fullan & Langworthy, 2013; Mishra & Koehler, 2006).

Overall, Leuphana University may not have fully realised transdisciplinary, deep learning when the study was conducted seven years ago, but it remains an expressed vision. Transdisciplinarity is a 'prominent concept' in research and teaching at the university. It is 'at the heart of the university's strategy ... based on the conviction that the established academic disciplines require ... supplementation in order to do justice to the complexity of academic topics and social challenges' (Leuphana University, 2024, para. 10).

The university now has five research schools (faculties) structured around transdisciplinary approaches to address complex challenges and problems: Education, Culture and Society, Management and Technology, Sustainability, and Public Affairs (Leuphana University, 2025a). The Institute for Sustainable Development, for example, maintains that 'transdisciplinary learning [provides] research-based learning, active integration, and the right balance between science and societal goals' (Tuvshinbayar, 2023, para. 4).

In an accountable self-assessment, after exploring the politics and practice of institutionalising transdisciplinarity at Leuphana University, Vienni-Baptista and Rojas-Castro (2020) observed (a) a mid-level transition to transdisciplinarity because (b) policies and practices had both hindered and reinforced each other. They concluded that their iterative interplay must be managed and led with foresight and tenacity (see also Cervantes et al., 2018).

DISCUSSION AND RECOMMENDATIONS

We coined the neologism *transdisciplinary deep learning* (aka *transdeep learning*) for this think piece. In our opinion, the import of the comma was resolved – it matters, and it changes the nature of learning. We respectfully suggest that transdeep learning, although not yet well articulated, is a legitimate, warranted construct provided that people respect the synergistic interplay between deep learning and transdisciplinary

TABLE 2 Comparison of deep learning and transdisciplinary learning.

Deep learning	Transdisciplinary learning
<i>Engage with complexity</i> with profundity of thought during self-directed, inquiry-based personal learning	<i>Engage with complexity</i> by connecting with diverse others to learn and problem-solve together and co-create knowledge
<i>Six Cs of deep learning</i> (core learning outcomes): citizenship, character education, creative thinking and imagination, communication, collaboration, and critical thinking and problem-solving; once learned, students can transfer knowledge, skills, and attitudes to new contexts beyond where they were originally learned	<i>Transdisciplinary knowledge</i> (arising from TD learning) is complex (use leverage, self-adapt, and evolve); embodied (owned by everyone who helped create it); emergent (always becoming, changing, and evolving – not static); and cross-fertilised (arises from exchange of ideas and information among diverse actors)
<i>Deep learning mindset</i> : each person (a) internalises simple ideas; then (b) draws on these to process more and different, difficult ideas; and (c) continues until able to internalise very complex ideas (process thoughts to deeper and deeper levels of abstraction); this culminates in one's own mental framework of how to interpret an issue	<i>Transdisciplinary mind habits</i> : each person learns perceiving, patterning, abstracting, embodied thinking, modelling, playing, and synthesising. These six cognitive skills enable them to think their way through the process of integrating diverse viewpoints to cocreate new knowledge
<i>Inquiry-based learning</i> : intellectually curious students arrive at an understanding of a concept by themselves (self-directed investigation and discovery); they dig deep, connect the dots, and create their own framework for interpreting issues (likely differs from others)	In a <i>knowledge-creation community</i> , people depend on (a) shared boundary objects, (b) mutual learning and collaboration and (c) metacognition, so they can cocreate a then-shared framework for interpreting the issue (likely different from each person's framework)
<i>Deep learning cycle for an individual</i> : learning, doing, knowing, adapting, inventing, and living to the point that learning and living become indistinguishable; another approach has five stages: meaning-making, investigate, synthesis, create and design, and communicate and reflect	<i>Transdisciplinary learning cycle in a group</i> : use each person's initial idea as input into a <i>group</i> endeavour; all involved deliberate its meaning until there is a convergence of viewpoints leading to new knowledge; the group process inspires each person to shift positions leading to the cycle repeating itself with each new input

learning, which are aligned but distinctly different (see Table 2). A key takeaway is that one can experience deep learning *without* being exposed to a transdisciplinary learning pedagogy or experience. Transdisciplinary learning is intrinsically deep and collective but not solitary. Deep learning is personal and solitary but not transdisciplinary as understood herein.

To elaborate, deep learning occurs *within each person* as they gain new, reflective self-knowledge as well as cognitive knowledge (even metaknowledge). Transdisciplinary learning can also be framed as internal given the creation of transdisciplinary mind habits for individual synergistic and integrative thinking. *But* – deep learning that is also transdisciplinary, which is inherently deep, requires cocreating knowledge *with diverse others* leading to profound *depths of shared knowing*. This was a major takeaway from this think piece.

We further suggest that transdisciplinary learning depends on people cocreating a mutually *shared* lens of interpretation (shared framework) that can lead to new, agreed-to knowledge, which is different from each person's framework and knowledge. Ironically, personal deep learning best ensures that this collective, mutually shared intellectual framework emerges and is entrenched forever in each person's mind and concurrently jointly held by all involved in its cocreation.

We ultimately concluded that transdeep learning is not a solitary affair. It involves each person concurrently coexperiencing, while interacting with others, deep learning *and* transdisciplinary learning in a context respectful of the academy/wider-world connection. It is

a synergistic blend of solitary (deep) and collective (trans) learning intent on authentically connecting university and lived experiences, so that university students and society can both learn and benefit. Students are socialised to be world-minded citizens. Society comes to view universities as fundamental to shaping the future and changing the world. 'Trans' means beyond to a new space, and 'deep' means extending and reaching inward and downward toward meaning and insight. Transdeep learning to a new, more meaningful and insightful space is the wave of the future for higher education.

University administrators and faculty members worldwide are thus encouraged to consider the powerful potential of intentionally institutionalising transdeep learning. To that end, they should strategically, sequentially, (a) first institutionalise deep learning and (b) then transdisciplinary learning, which are related but distinct learning styles (see Table 2). This could lead to (c) institutionalising transdisciplinary, deep learning per ASU and Leuphana University's examples. Once the latter is institutionalised university-wide, those involved could (d) more fully engage with institutionalising transdeep learning, perhaps in a transversity (see McGregor, 2024).

CONCLUSION

We offer transdeep learning as an avant-garde, next-level construct that can inform higher education's strategic planning, academic infrastructure, curricular development, pedagogy, and research within and outside the academy via ties with industry, government and civil society. Reconstructing a university toward transdisciplinary deep learning: 'goals is not a simple endeavor, but neither is it an impossible task' (Cervantes et al., 2018, p. 262). Per the tenets of a think piece (Kennedy, 2007; McGregor, 2018), readers are encouraged to engage the transdeep learning idea to determine its merit and how best to further conceptualise, theorise, and operationalise related higher education pedagogy and institutionalisation policies to make it reality. This is a timely conclusion and recommendation given the burgeoning movement toward institutionalising transdisciplinarity in higher education and the vision of transversities.

AUTHOR CONTRIBUTIONS

Sue L. T. McGregor: Conceptualisation; writing – original draft; methodology; writing – review and editing. **Amani K. Hamdan Alghamdi:** Review.

FUNDING INFORMATION

No funds, grants, or other support were received to prepare this manuscript.

CONFLICT OF INTEREST STATEMENT

The authors report there are no competing interests to declare regarding funding, employment, financial, or non-financial interests.

DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

ETHICS STATEMENT

No humans were involved in this research.

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Endnote

¹ The Zurich approach uses different criteria to describe transdisciplinary knowledge. It is 'grounded in (a) *contextuality* (knowledge is developed in the context of application), (b) *heterogeneity* (diverse content and characters are creatively used) and (c) *social accountability* and *reflexivity* [leading to *socially robust* knowledge]' (McGregor, 2023, p. 7; see also Klein et al., 2001; McGregor, 2015).

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How to cite this article: McGregor, S. L. T., & Hamdan Alghamdi, A. K. (2025). Transdeep learning in higher education: Institutionalising transdisciplinarity. *Review of Education*, 13, e70076. <https://doi.org/10.1002/rev3.70076>