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Educating for sustainable and equitable futures: A transdisciplinary future-making capability framework

Giedre Kligyte [a,*], Jacqueline Melvold [a,b], Susanne Pratt [a], Bella Bowdler [a]

[a] Transdisciplinary School, University of Technology Sydney, Australia
[b] W.A. Franke Honors College, University of Arizona, United States

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ABSTRACT

Debates around the purpose of higher education reflect diverse societal aspirations, from enhancing national economies to addressing sustainability issues and advancing social justice. Educators seeking to contribute to positive social and environmental futures must navigate these varied and sometimes conflicting future visions to identify the capabilities needed for transformative action within their particular context(s). Drawing on diverse areas of literature and over a decade of transdisciplinary education practice, we present a reflexive process of identifying and articulating capabilities to ensure our transdisciplinary education efforts support transformations towards more sustainable, equitable and just futures. Adopting the term 'transdisciplinary future-making capabilities' and drawing on the human development framing of capabilities, we propose a *Transdisciplinary Future-making Capability Framework* developed through a framework synthesis review. This framework offers an expansive view of capabilities required to create desirable futures, serving as an example of collaborative sensemaking that educators can undertake in navigating and integrating diverse perspectives into their own practice. The paper concludes by highlighting the transformative potential of transdisciplinarity to enrich and redefine higher education approaches.

1. Introduction

Higher education is an inherently future-oriented endeavour. Whether it explicitly engages with the concept of futures or not, higher education is entwined with social imaginaries about anticipated future needs (Gidley, 2012). While traditionally, the role of higher education institutions has been closely linked with knowledge creation, transfer and exchange (Smolentseva, 2023), increasingly, universities are positioned across popular, policy and academic discourses as being central to addressing future challenges (Clare, 2022; O'Riorda et al., 2020; Redman & Wiek, 2021; UNESCO, 2022). As a result, many universities have expanded their mission to encompass a broader societal role, focusing on generating social impact and contributing to the public good (Godonoga & Sporn, 2023; Király & Géring, 2021; Lewis et al., 2025). Despite this broadening remit, contemporary debates feature divergent conceptions of the purpose of higher education, aligned with a range of implicit societal goals. These include enhancing national economic competitiveness through the employability agenda (Norton, 2022; World Economic Forum, 2023), addressing current and future challenges and enabling societal transitions towards sustainability (O'Riordan et al., 2020; Redman & Wiek, 2021; UNESCO, 2017), and promoting fairness, freedom and democratic ideals (Smolentseva, 2023; UNESCO, 2022; Walker, 2008).

* Corresponding author.
E-mail address: giedre.kligyte@uts.edu.au (G. Kligyte).

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Navigating these diverse future visions and goals can lead to paradoxes. For example, a university's public commitment to sustainability as a critical objective may coexist with efforts to drive economic growth and innovation, potentially creating conflicting priorities (Shiel & Jones, 2016). Recognising that these tensions cannot be simply resolved, there are growing calls to reimagine universities as multidimensional, relational and *trans*disciplinary spaces – places that embrace a plurality of perspectives and cultivate wisdom through critical reflection, dialogue, experimentation and collaboration across differences (Facer, 2022; Khoo, 2023; Mascolo, 2023; Godonoga & Sporn, 2023). Advocates argue that through pluralistic dialogue, intellectual humility, and integrative thinking, a reimagined transdisciplinary university can better prepare individuals to respond to complex challenges, support continuous societal self-renewal and contribute to collective transformation (Khoo, 2023; Mascolo, 2023). In this context, an increasing number of universities are explicitly adopting transdisciplinary approaches in their education programs (Vienni-Baptista & Klein, 2022).

Whether education is perceived to contribute to the common good and sustainable futures or simply ensuring individuals' competitiveness in the labour market, the notion of future needs is closely tied to the concept of capabilities. This involves what individuals must develop and master through education to realise these future societal objectives (Barnett, 2004). Aligned with divergent future visions and end goals, a plethora of existing frameworks feature sustainability competencies (Jordan et al., 2021; Redman & Wiek, 2021; Rieckmann, 2012; UNESCO, 2017; Wiek et al., 2011), entrepreneurial competencies (Lans et al., 2014), employability competencies (Jackson, 2014; OECD, 2020; The Foundation for Young Australians, 2017; World Economic Forum, 2023), as well as 21st-century capabilities (ACARA, 2022; Griffin et al., 2012; Rychen & Salganik, 2003; Trilling & Fadel, 2009; Voogt & Roblin, 2012). Frameworks outlining capabilities explicitly linked with futures thinking, practices and concepts include futures consciousness (Ahvenharju et al., 2018), future orientation (Hideg & Nováky, 2010), futures literacy (Miller, 2007), and anticipation (Poli, 2017), among others. This raises the question: amidst this complexity, how can educators identify and create opportunities for learners to develop the capabilities necessary to advance sustainable and equitable futures[1]?

Scholars increasingly agree that profound social and environmental shifts demand new types of knowledge and skills, such as transdisciplinarity, systems and futures thinking, complex problem-solving and collaboration, among others (Bammer et al., 2020; Knechtel, 2024; UNESCO, 2017; Voogt & Roblin, 2012). They also assert that in an era defined by complexity, individuals need capabilities that help them engage with uncertainty, make sense of emergent issues and opportunities, and work together –creatively, skilfully and ethically – to bring about positive societal transformations (Montuori, 2010; Morin, 2001; Facer, 2022).

Despite an apparent consensus about the nature of these capabilities, there is a lack of commonly agreed-upon frameworks to guide educators in developing them – a fragmentation that is seen as undermining the legitimacy, transferability, and recognition of these capabilities across different contexts (Brundiers et al., 2021; Redman & Wiek, 2021). Efforts to consolidate existing knowledge and mitigate duplication and fragmentation include Redman and Wiek's (2021) unified framework of sustainability learning objectives, Brundiers et al. (2021) convergence-seeking exploration of sustainability competencies, Bammer et al. (2020) articulation of integration expertise, and Voogt and Roblin's (2012) analysis of international frameworks for 21st-century capabilities. However, many critiques point out that capability frameworks are neither neutral, universally relevant, nor easily applicable across all contexts (Facer & Sriprakash, 2021; Wheelahan et al., 2022). National and cultural differences, historical and economic realities and local societal goals influence how education programs are constructed and evolve. Educators must navigate competing societal discourses specific to each context, aligning capabilities with local realities to embed them into education programs. The reflexive and relational process of contextualising and embedding knowledge into local settings becomes critical.

In this paper, we, a group of colleagues working at the Transdisciplinary School within University of Technology Sydney (UTS), Australia, draw on diverse areas of education research and over a decade of our transdisciplinary practice, to grapple with the question '*How can we interpret and align diverse education frameworks to identify and articulate capabilities to ensure our transdisciplinary education efforts support the transformation towards sustainable, equitable, and just futures'?* Our aim is to synthesise existing knowledge, demonstrating how it can be contextualised and integrated with our transdisciplinary education practice. This serves as an example of collaborative sensemaking that educators can adopt in navigating and incorporating diverse capability frameworks into their own practice.

In our exploration, we draw on transdisciplinarity as a boundary-spanning, critical and self-reflexive practice that integrates academic and disciplinary knowledge with practical knowledge and lived experience (Jahn et al., 2012; Klein, 2004; Polk & Knutsson, 2008). Transdisciplinarity frames paradoxes as drivers for social change, embracing them as opportunities for reflection, debate, and experimentation. This approach promotes a both/and mindset, encouraging the exploration of 'grey areas' where conflicting elements coexist, fostering negotiated understandings that can spark innovation and creativity (Miller, 2020). It helps us reconcile diverse societal visions of desirable futures and identify the capabilities needed to achieve them.

A transdisciplinary lens also emphasises that the capabilities required for graduates to tackle complex challenges across disciplines and professions are not static traits of individuals. Instead, they are relational, dynamic, and context-dependent, emerging and being enacted in specific situations. Acknowledging the complex terrain of futures-related terms circulating in academic discourse, along with some futures scholars (see Lehtonen et al., 2022), we adopt the term 'transdisciplinary future-making capabilities' to encapsulate our aspirations to educate students who will work across differences to create and advance positive (and not pre-determined) futures for their communities, disciplines, professions, industries, and society at large (Whyte et al., 2022). We define transdisciplinary future-making capabilities as those enabling students to translate their ideas and expertise into tangible outcomes in real-world

[1] While social dimensions are inherent to the definition of sustainability—as affirmed in Principle 1 of the Rio Declaration and reflected in SDGs 5 and 10—we explicitly include the term 'equitable' to foreground social justice goals driving our education efforts, which can sometimes be overlooked or diluted in sustainability discourse and practice.

situations, and in collaboration with other actors. While this may involve learning futuring methodologies and becoming so-called 'futures literate' (Miller, 2018), our overarching ambition is to develop students' ability to work towards desirable futures by engaging with real-world complexity through action and experimentation.

To situate our process of collaborative sensemaking, we first outline the context of our transdisciplinary higher education practice. We then review relevant scholarship and discourses associated with transdisciplinary education and articulate the human development framing of capabilities inspired by the theorising of Amartaya Sen (1999) and Martha Nussbaum (2011). We then examine the existing literature across a range of scholarly areas, alongside our own practice and undertake a 'framework synthesis' review (Brunton et al., 2020) to formulate a *Transdisciplinary Future-making Capability Framework*. Through this, the paper makes two key contributions to futures scholarship and practice. First, it outlines a reflexive sensemaking process to identify and articulate transdisciplinary future-making capabilities to ensure our education efforts contribute to desirable futures. Second, it highlights the transformative potential of transdisciplinary education through an emphasis on its potential to develop graduates' capabilities to facilitate societal transformations.

2. Transdisciplinary higher education practice and our context

Complex problems—such as climate change, inequality, and social justice—extend beyond the boundaries of individual disciplines, organisations, and industries (Bammer et al., 2020; Dorst, 2018; Polk, 2014). Scholars increasingly argue that contemporary challenges demand transdisciplinary integration of professional expertise, academic knowledge, and local, practical, and Indigenous wisdom (Klein, 2004; Polk & Knutsson, 2008), along with intergenerational perspectives (Bodiford & Whitehouse, 2020). Transdisciplinary education is an approach that seeks to bridge these divides, equipping students with the skills and knowledge necessary for integrative responses (Vienni-Baptista & Klein, 2022). Importantly, transdisciplinarity is not merely a mode of problem-solving but a deeply relational, reflexive, and creative practice that embraces complexity, uncertainty, and emergence (Adams & Maguire, 2023; Lawrence, 2024a; Mascolo, 2023). Thus, transdisciplinary education must also foster students' openness to plurality of perspectives, integrative thinking, and an awareness that knowledge evolves through dialogue, self-organisation, and the dynamic interplay between individuals, collectives, and the systems they inhabit (Adams & Maguire, 2023; Brown, 2018; Montuori, 2010; Morin, 2001). By enabling conditions for mutual learning, collaboration, and reflexivity, transdisciplinarity can also facilitate future orientation, innovation and systemic approaches to transformation across sectors, well beyond university classroom (Baumber, 2022; Klein, 2017; Kligyte et al., 2024).

UTS's Transdisciplinary School is among several other Australian higher education institutions experimenting with transdisciplinary approaches to education, including the University of Sydney, the Australian National University, and Western Sydney University. The global peers in transdisciplinary education include the University of Arizona, Arizona State University, ETH Zurich, and The University of Berlin, among others (Philipp & Schmohl, 2023).

Over 25 years, UTS has advanced transdisciplinary education, starting with the Institute for Sustainable Futures in 1997, offering transdisciplinary graduate research programs (Riedy, 2022). In 2014, UTS launched the pioneering and award-winning transdisciplinary Bachelor of Creative Intelligence and Innovation (BCII) degree, comprising a 'core' degree in one of 27 fields, such as business, science, communications, and design, alongside a 4-year transdisciplinary curriculum fostering cross-disciplinary collaboration, creativity and innovation. Building on the BCII's success, UTS now offers a Diploma in Innovation, postgraduate-level programs, transdisciplinary doctoral training, and, since 2022, a Transdisciplinary Electives Program, integrated into all UTS undergraduate degrees.

Our transdisciplinary education practice is shaped by societal discourses and visions that both enable and constrain how our education programs come into being. As in many other developed nations, Australian higher education predominantly functions within the human capital paradigm (Moodie & Wheelahan, 2023). Through policy and popular discourse, the primary objective of Australian higher education is framed around sustaining or enhancing the global competitiveness of the national economy (Norton, 2022). This economy-driven vision of education is intrinsically linked with the employability agenda, whereby universities are expected to prepare 'job-ready' graduates who fit the needs of the present and future industries and economies (Department of Education, 2020). Within this dominant employability frame, Transdisciplinary School's education programs emphasise innovation, entrepreneurship, and working in partnerships with industry, community, and government organisations. The programs are designed to provide students with practical, cutting-edge learning and industry experiences by working on real-world briefs.

Reflecting a new educational agenda emphasising universities' role in supporting society in addressing urgent social and environmental issues, UTS was one of the first Australian universities to sign a climate emergency declaration in 2019. In line with this global discourse, our transdisciplinary programs encourage students to embrace a future-oriented, globally responsible perspective, developing an identity as change-makers and social innovators. To that end, Transdisciplinary School's programs aim to develop graduates' capacity to work actively and inclusively across diverse contexts for positive environmental and social outcomes, including developing the Indigenous Graduate Attribute (Page et al., 2019), and contributing to the Sustainable Development Goals (SDGs) (UNESCO, 2017).

Finally, our transdisciplinary education programs are built on creative foundations, established to promote creative thinking across all disciplines (Le Hunte et al., forthcoming). In alignment with Robert Sternberg's (2021) concept of 'transformational creativity,' which aims to make a positive, meaningful, and enduring difference in the world, unlike 'transactional creativity,' which seeks immediate and primarily economic rewards, our transdisciplinary education programs are designed to develop students' ability to tolerate ambiguity, collaborate, experiment, be open to new information and perspectives, and creatively adapt methods and approaches. Futures is a key theme supporting this development. Throughout their study, students are introduced to various futuring

methods, such as horizon scanning (Cuhls, 2020), backcasting (Robinson, 2003) and Causal Layered Analysis (Inayatullah, 1998), alongside other transdisciplinary innovation and collaboration approaches like rich pictures (Checkland, 1981), actor mapping and engagement (Pohl, 2020) and experimental prototyping (Gengnagel et al., 2015). However, students are not simply taught futures methodologies and orientations; they are encouraged to explore, experiment with, critique, combine and extend various approaches across different domains and challenge spaces. Coming from a range of different degrees at UTS, students learn to use these methods to inquire, question assumptions, collaborate and innovate across different fields, responding to urgent social and environmental challenges. Through this, students are not merely developing problem-solving skills but are gaining capabilities required for an ongoing ethically grounded future-oriented, critical and reflexive practice of 'transdisciplinary inquiry' (Lawrence, 2024b) – boundary work that bridges a plurality of perspectives and challenges assumptions to co-create socially responsive change.

Our education practice at the Transdisciplinary School emerges from and is shaped by this dynamic environment. Anchored in this specific context, in the next section, we articulate a relational and contextualised concept of capabilities.

3. Conceptualising capabilities

In the higher education and sustainability education literature, there are ongoing debates around the nature and definitions of concepts of 'capabilities', 'competencies', 'capacities' and 'attributes' (see Holdsworth & Thomas, 2021; Redman & Wiek, 2021; Shephard et al., 2019). While the education for sustainable development field has largely adopted the notion of sustainability 'competencies' (Shephard et al., 2019; UNESCO, 2017; Wiek et al., 2011), the Australian Quality Framework refers to 'capabilities' and 'attributes' in determining the levels of educational outcomes (Holdsworth & Thomas, 2021). Futures 'attitude', 'literacy' and 'consciousness' are also commonly used in the futures scholarly community (Ahvenharju et al., 2018). Many authors observe that these concepts are used interchangeably, often without a justification for using a particular term (Barrie, 2006; Hager et al., 2002). These terms are typically understood to have the same meaning, encompassing individuals' cognitive, behavioural and affective characteristics, resulting in their ability to apply the specified knowledge, skills and dispositions in relevant disciplinary or professional contexts (Stephenson, 1998).

In our work, we adopt the notion of transdisciplinary future-making capabilities. Along with Stephenson (1998), we see capability as a broader term that is more 'forward-looking and concerned with the realisation of potential' (p. 3). We view capabilities as going 'beyond achievement of competence in present day situations to imagining the future and contributing to making it happen' (Stephenson, 1998, p. 3). To emphasise the relational and contextual notion of future-making capabilities, in contrast to the individualised notions of 'competencies' and 'attributes', we draw on the capabilities approach. Originating from the human development field, the *capability to function,* as articulated by Amartaya Sen (1999) and Martha Nussbaum (2011), includes not only what individuals are 'able to do and be' (Robeyns, 2017, p. 9), but also the freedom and environmental conditions for individuals to be able to 'be and do in ways which they have reason to value' (Walker, 2015, p. 417). This implies that developing transdisciplinary future-making capabilities involves not only equipping individuals with the relevant knowledge and skills – the potential to achieve 'functionings' – but also developing their ability to 'function' – exercise their capabilities – within both the education institution and broader society, today and in the future (Walker & McLean, 2013).

The distinction between *capability* and *functioning* in the capability approach is critical because it emphasises the role of contextual factors influencing individuals' capacity to act and create change in real-world settings (Walker, 2008). Social arrangements can shape these functionings – either diminishing or enhancing them. For example, an individual might have a valuable perspective and recognise its importance yet feel silenced in environments where certain identities are privileged over theirs (Walker, 2008). Therefore, achievement of capabilities has also been described as 'having the resources, being able to mobilise them in line with individual internal conversion factors and deciding to do so, because they are life-enhancing and enabled by environmental factors' (Lozano et al., 2012, p. 141).

This contextualised, relational, and agentic concept of capabilities aligns with the notion of *future-making* (Lehtonen et al., 2022) and supports our aspiration as educators to develop future leaders and change-makers who can address complex issues across various contexts and time horizons. Transdisciplinarity further reinforces this relational perspective, highlighting the importance of engagement with diverse perspectives to create holistic, context-specific responses, and empowering individuals to navigate and transform their environments.

In the next section, we outline our approach to reviewing and synthesising the relevant literature and existing capability frameworks to articulate the Transdisciplinary Future-making Capability Framework, aligned with the contextual realities of our transdisciplinary education practice.

4. Methodology

Existing capability frameworks typically involve experts and industry stakeholders to identify what is required to address future needs—see Brundiers et al. (2021) Jackson (2010), Jordan et al. (2021), Redman and Wiek (2021) and Rieckmann (2012), among others.

4.1. Methodological rationale

Guided by the relational and contextualised concept of capabilities, we build on the existing scholarship, creating a dialogue between established understandings of capabilities and our transdisciplinary education practice. Our research asks: *How can we*

interpret and align diverse education frameworks to identify and articulate capabilities to ensure our transdisciplinary education efforts support the transformation towards more sustainable, equitable, and just futures? We adopt a modified 'framework synthesis approach' in reviewing selected capability frameworks (Brunton et al., 2020), using a narrative review approach, rather than a systematic review approach (Sukhera, 2022). Our narrative framework synthesis approach involves engagement with existing theoretical and empirical literature to create an initial conceptual framework for understanding salient issues. This preliminary framework is then refined by incorporating new theories and data, resulting in a synthesised framework through iterative prototyping (Brunton et al., 2020).

We began our collaborative sensemaking by first compiling a range of capability frameworks from various sources, including research publications and grey literature such as industry or intergovernmental organisation reports. Our goal was not to conduct a systematic literature review, compile an exhaustive list of existing frameworks or create a universally applicable framework of transdisciplinary capabilities. Instead, we aimed to engage with a range of diverse capability frameworks as a sensemaking process aligned with critical review process (Grant & Booth, 2009) to inform and enhance our transdisciplinary education practice.

4.2. Search, inclusion and exclusion criteria

We identified relevant literature through keyword searches using terms like 'capabilities', 'future', 'education', 'framework', along with synonyms such as 'competences.' We conducted separate searches with additional qualifiers including 'sustainable', 'transdisciplinary', 'employability' and 'innovation' in both titles and full texts. The resulting sources spanned multiple scholarly areas, reflecting the diverse educational goals that have influenced and continue to shape our transdisciplinary education programs. The frameworks reviewed covered areas related to employability, 21st-century skills, general or transferable capabilities, as well as frameworks from transdisciplinary, entrepreneurship, innovation, and environmental education literature. Futuring capability frameworks were included where they were explicitly linked to achieving impact or enabling social change toward more sustainable and equitable futures.[2]

Given the transdisciplinary nature of our programs, we were curious to find that while many existing frameworks referenced aspects of transdisciplinarity—such as systems thinking, collaboration, stakeholder engagement, and reflexivity—only a few clearly outlined a coherent set of transdisciplinary capabilities with detailed descriptions. Even then, they are often associated to research or professional practices (for example, see Bammer et al. 2020), rather than as capabilities developed through education. Consequently, we excluded studies that addressed relevant themes but did not clearly articulate capabilities and their descriptors. Through an iterative process using (i) articles published in English, and (ii) articles published since 2000—when education systems began shifting towards 21st-century capabilities, with a growing focus on sustainability capabilities emerging around 2010—a total of 23 distinct frameworks were identified. At this point, thematic saturation was reached, yielding no novel conceptual categories.

4.3. Analysis, interpretation and reflexivity

The capabilities outlined in these selected frameworks and their definitions were collated into a database. This database included contextual details about the nature of the source, key terms and concepts used, the methodology for developing the framework, the lineage of ideas (if they were building on other existing frameworks or conceptualisations), as well as the area of literature to which it contributed. Capabilities embedded in the curriculum documents for our transdisciplinary education programs, including graduate attributes, course intended learning outcomes and associated descriptors, were collated in the same database.

To support our framework synthesis, we conducted a thematic analysis (Clarke & Braun, 2017) by examining capabilities present in both the literature and our educational practice, identifying categories and synthesising thematic codes such as 'analytic', 'creative', 'experimental', and 'normative', among others. Two authors conducted independent thematic coding, followed by discussions and iterative reviews of the results. We then synthesised the definitions of transdisciplinary future-making capabilities and crafted accompanying questions – such as 'What is', 'What could be', 'What should be' – to describe each capability in a clear, one-sentence format. This approach was inspired by Jantsch's (1972) proposal for a systems approach to university education and Brown and Lambert's (2012) framework for collective learning for transformational change.

The capabilities were organised into visual diagrams to illustrate their interrelations. Various configurations and spatial arrangements were explored to show the interrelationships between these capabilities, particularly in enabling individuals to convert opportunities into functionings and create real-world impact. Inspired by a colleague's suggestion to use metaphoric thinking for richer and more nuanced representation, we moved from a traditional flowchart with multiple arrows to a metaphorical representation of a tree. In this metaphor, visible and observable capabilities (such as analytic, creative, and experimental) are depicted in the leafy crown of a tree, representing behaviours, outcomes, and work with tangible artefacts. Foundational, value-related relational capability is positioned in the root system beneath the ground. Agentic and reflexive capabilities function like the sap flowing through the tree's trunk, both animating other capabilities and connecting the less visible relational capability to the more outwardly expressed ones, like analytic, creative and experimental.

Throughout this process, we shared draft versions with university stakeholders and colleagues who provided critical feedback and alternative suggestions for representing capabilities and their relationships. Input from international transdisciplinary scholars and conference audiences also informed revisions. There was a strong consensus on the capabilities themselves, with the tree metaphor

[2] Importantly, although Indigenous and decolonising capabilities are of growing importance in our transdisciplinary education practice, they were not included in this analysis due to potentially reductive analysis based solely on published literature.

widely seen as an effective way to communicate their functions and interrelatedness, sparking meaningful dialogue.

Our iterative approach prioritised reflexivity and dialogue, in contrast with protocol-led literature reviews that assume uniformity across contexts. Although we do not claim this process is replicable across all educational contexts, we share this as a practical example to help others navigate and integrate diverse capability frameworks within their own unique settings. We emphasise that our proposed framework serves as sensemaking device rather than 'plug-and-play' solution, encouraging scholars and educators who consider adopting this framework to adapt it to their unique contexts. In the next section, we outline the Transdisciplinary Future-making Capabilities Framework, as a provisional articulation of capabilities, open to further development and dialogue.

5. Transdisciplinary future-making capabilities framework

The proposed Transdisciplinary Future-making Capabilities Framework consists of eight key capabilities:

- Analytic—understand complex situations (WHAT IS);
- Creative – imagine and explore alternatives (WHAT COULD BE);
- Experimental – test ideas in real-world contexts (WHAT CAN BE);
- Normative – exercise judgement to create value (WHAT OUGHT TO BE and WHY);
- Transdisciplinary know-how – assemble a transdisciplinary process and justify choices (HOW TO DO IT);
- Relational – act with contextual, intersubjective awareness and holistic understanding of complexity (WHERE IT SHOULD BE and WHO SHOULD BE INVOLVED);
- Reflexive – understand self in relation to others and the world (WHAT IS MY ROLE); and
- Agentic – act purposefully (HOW SHOULD I ACT).

Table 1 provides definitions of these capabilities and articulates them in relation to the existing frameworks and literature we analysed.

6. Visualising the transdisciplinary future-making capabilities framework

Fig. 1 represents the metaphorical visualisation of the Transdisciplinary Future-making Framework. Metaphors, as powerful framing devices for sharing understanding, can take various forms including verbal expressions, phrases, and visual or multimodal representations (Forceville, 2024; Lakoff & Johnson, 1980). In futures and transformation studies, the value of metaphoric language is widely acknowledged (Judge, 2016; Milojević & Inayatullah, 2015), particularly in enabling people to comprehend abstract concepts more concretely (Riedy et al., 2018). The metaphor used to visualise our framework invites diverse interpretations, such as viewing it as a rhizome, a tree-like structure with intertwined branches and roots, or appearing as mycelial networks, emphasising the contextual, relational, and interconnected aspects of the capabilities.

Unlike capability frameworks that prioritise measurement, outcomes, and observable behaviours, the Transdisciplinary Future-making Capabilities Framework uses metaphor to stimulate relational reflexivity. While this representation simplifies the complex, non-sequential interrelationships between capabilities and does not use conventional systems modelling tools, it aims to depict the capabilities as interconnected elements of a dynamic, living system. The metaphorical visualisation of the framework also reflects the transformative nature of transdisciplinary education, where inputs undergo alchemical metamorphosis, yielding outcomes greater than the sum of their parts (Nicolescu, 2002). Through this metaphor we highlight that all transdisciplinary future-making capabilities are necessary, each playing a unique and indispensable role in transforming opportunities into functionings, and contributing to creating desirable futures.

7. The value of transdisciplinary future-making capabilities

Our engagement with the literature and our practice revealed a largely uniform understanding of the capabilities needed for the future across different areas of scholarship and practice, similar to the findings of Redman and Wiek's (2021) systematic literature review. However, the exploration also made us reflect on the unique aspects of the transdisciplinary future-making capabilities developed in our education programs. Through the sensemaking process outlined in this paper, we asked ourselves whether and how transdisciplinarity specifically enables students to convert their knowledge, skills, and dispositions – opportunities – into functionings in real-world contexts. Similarly, we pondered what, if anything, is transdisciplinary about the future-making capabilities we identified through the study.

Drawing on our practice and transdisciplinary education literature, we argue that transdisciplinarity offers a distinctive contribution to existing models of sustainability, 21st-century, and employability capabilities. It emphasises students' capacity to understand the complexity underpinning contemporary real-world challenges (Bammer et al., 2023; Baumber, 2022), the application of participatory and integrative methodologies–including futuring–to engage with diverse perspectives (Baumber, 2022; McGregor, 2017), and a strong focus on reflexivity and relationality (Le Hunte, 2021; van der Bijl-Brouwer, 2022). In practical terms, in our education programs, students use tools such as system maps, influence diagrams, and causal loops to analyse complex systems and design adaptive interventions like safe-to-fail experiments to address uncertainty (Baumber, 2022; Snowden and Boone, 2007). Collaboration in multidisciplinary teams exposes students to different disciplinary insights, while the inclusion of practice-based, local, and Indigenous knowledges broadens their understanding of diverse perspectives and mental models (Baumber, 2022; Kligyte et al., 2022).

Table 1
Description of capabilities within the Transdisciplinary Future-making Capability Framework.

Capability	Description	Terms used in the reviewed literature
ANALYTIC - understand complex situations **WHAT IS**	The **analytic capability** entails the ability to apply theories and knowledge to analyse, interpret and analyse complex systems from a range of perspectives, across local and global scales and different time horizons to understand system components, interrelations and dynamics, and to synthesise a holistic larger-picture view, including contradictions, emergent patterns and unknowns attendant in complex situations. It requires individuals to apply existing theories and knowledge to observing, recognising and critically evaluating patterns in the world, including incompatible and contradictory understandings of situations.	• Systems thinking (Bammer et al., 2023; Baumber, 2022; Lans et al., 2014; Le Hunte, 2021; Redman & Wiek, 2021; UNESCO, 2017) • Context-based (Bammer et al., 2023) • Contributory expertise: 'knowing that' (Bammer et al., 2020) • Reconciling tensions and dilemmas (OECD, 2019) • Thinking – cognitive skills (Jordan et al., 2021) • Observing, perceiving, patterning, abstracting, synthesising (Henriksen, 2016; McGregor, 2017; Root-Bernstein & Root-Bernstein, 2001) • Systems perception (Ahvenharju et al., 2018)
Creative – imagine and explore alternatives **WHAT COULD BE**	The **creative capability** involves generating new ideas, speculating and creatively problem-solving to probe the unknowns, reframe current understandings, imagine alternative futures and generate new possibilities that integrate a diversity of views; synthesise and express ideas in multiple modalities. The creative capability encompasses lateral thinking and imagination, expanding the possibilities of 'what could be'.	• Creativity and innovation (Gardiner, 2020; Le Hunte, 2021; Voogt & Roblin, 2012) • Foresight/futures thinking, anticipatory competence (Lans et al., 2014; Redman & Wiek, 2021; UNESCO, 2017) • Creating new value (OECD, 2019) • Transforming (Root-Bernstein & Root-Bernstein, 2001) • Scholarship, research and inquiry (Barrie, 2012) • Openness to alternatives (Ahvenharju et al., 2018)
Experimental – test ideas in real-world contexts **WHAT CAN BE**	The **experimental capability** encompasses developing and carrying out concrete interventions, through play or deliberate experimentation, to learn about system dynamics and constraints to iterate, adapt and pivot to improve proposals and initiatives. This capability is often instrumental in testing and developing ideas in entrepreneurial initiatives to understand 'what can be', and it forms a core component of real-world 'living labs'.	• Addressing real world challenges (Baumber, 2022) • Applied imagination and invention (Trilling & Fadel, 2009) • Play (Henriksen, 2016; McGregor, 2017; Root-Bernstein & Root-Bernstein, 2001) • Developing initiative and enterprise (Jackson, 2014) • Flexibility and adaptability • (Jackson, 2010; Trilling & Fadel, 2009) • Implementation competence (Redman & Wiek, 2021)
Normative – exercise judgement to create value **WHAT OUGHT TO BE and WHY**	The **normative capability** comprises the ability to critically evaluate ideas and diagnose problem situations to make appropriate decisions that are worthwhile from different perspectives; propose and justify responses, including standing up for values and challenging the status quo if required; anticipate and assess the consequences of actions and proposals. The normative capability is often applied in the contexts of innovation, entrepreneurship and problem-solving, as well as in developing and evaluating proposals, initiatives and 'preferable' futures, and justifying 'what ought to be'.	• Critical thinking (Jackson, 2014; Trilling & Fadel, 2009; Voogt & Roblin, 2012) • Values-thinking (Redman & Wiek, 2021) • Integrated problem-solving (Jackson, 2014; UNESCO, 2017) • Normative competence (Lans et al., 2014) • Concern for others (Ahvenharju et al., 2018)
Transdisciplinary know-how – assemble a transdisciplinary process and justify choices **HOW TO DO IT**	The capability of **transdisciplinary know-how** concerns the ability to identify differences between disciplines, professional fields and experiences and evaluate their relevance in problem situations. It also necessitates maintaining a repertoire of methods for sourcing, evaluating, integrating, translating and transforming knowledges and experiences; assembling and applying these methods in a coherent boundary-crossing approach that is appropriate for the context and task (including facilitation of participative processes, abstraction, integration, synthesis, and so on); justifying choices and maintaining rigour of methodology whilst carrying out transdisciplinary exploration and integration processes.	• Metacognitive skills (McGregor, 2017) • Contributory expertise: 'knowing how' (Bammer et al., 2023) • Interactional expertise (Bammer et al., 2023) • Reflexive and dialogic skills (van der Bijl-Brouwer, 2022) • Epistemic intelligence (van der Bijl-Brouwer, 2022) • Integrative characteristic (Bammer et al., 2023) • Knowledge about boundary objects (McGregor, 2017) • Expert thinking (Trilling & Fadel, 2009) • Lifelong learning (Barrie, 2006; Jackson, 2014) • Strategic management (Lans et al., 2014)
Relational – act relationally with contextual, intersubjective awareness & holistic understanding of complexity **WHERE SHOULD IT BE, and WHO SHOULD BE INVOLVED**	The **relational capability** engages collaboration, pluralism and holism: • **Collaboration** - communicate, negotiate, resolve conflicts and collaborate with others to make decisions, integrate ideas and progress towards meaningful goals; connect, influence, inspire and	• Communication and collaboration (Bammer et al., 2023; Barrie, 2012; Gardiner, 2020; Jackson, 2014; Jordan et al., 2021; Trilling & Fadel, 2009; UNESCO, 2017; Voogt & Roblin, 2012) • Interpersonal competence (Wiek et al., 2011) • Integration competence (Redman & Wiek, 2021) • Social and intercultural interaction (Trilling & Fadel, 2009)

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Table 1 (*continued*)

Capability	Description	Terms used in the reviewed literature
	lead others to create communities of mutual learning; • **Pluralism** - seek out, invite and integrate a multiplicity of perspectives and worldviews; cultivate dialogic skills and be present, open, respectful, empathetic to others; be responsive to difference and attentive to power across all stages of participative inquiry, learning or creative process; • **Holism**: question dualism and separation (from nature and past/future generations, etc) and cultivate a sense of connection to the greater whole; notice and foster relationships between place, human and non-human others in communities, societies and ecosystems.	• Knowledge about community (McGregor, 2017) • Empathising (Henriksen, 2016) • Pluralistic (Bammer et al., 2023) • Power literacy (van der Bijl-Brouwer, 2022) • Synthesising / integration of diverse knowledges (Baumber, 2022; McGregor, 2017; Le Hunte, 2021) • Leadership and responsibility (Trilling & Fadel, 2009) • Relating - caring for others and the world (Jordan et al., 2021) • Time perspective (Ahvenharju et al., 2018)
Reflexive – understand self in relation to others and the world **WHAT IS MY ROLE**	The **reflexive capability** involves: • Maintaining a reflexive connection with self – own thoughts, feelings and body; be flexible, adaptive and regulate oneself in contexts of uncertainty and contradiction; utilise all five senses in learning and inquiry; • Critically reflecting on situations and modes of inquiry to discern values that underly different actions and choices (including one's own); question assumptions underlying existing rules, strategies and norms that underpin positionality, privilege and power afforded to people in particular situations; • Cultivating curiosity and mutual learning-orientation.	• Self-awareness and self-management (UNESCO, 2017; Jackson, 2014) • Reflexivity (Baumber, 2022) • Being – relation to self (Jordan et al., 2021) • Embodied thinking (Root-Bernstein & Root-Bernstein, 2001; Henriksen, 2016) • Normative (UNESCO, 2017) • Lifelong learning (Barrie, 2012; Voogt & Roblin, 2012) • Intra-personal competence (Redman & Wiek, 2021)
Agentic – act purposefully **HOW SHOULD I ACT**	The **agentic capability** entails the ability to enact a well-considered ethical and intellectual position led by a core sense of self, values and commitment to the greater good; take responsibility, drive initiatives and make a tangible and useful contribution towards meaningful goals with confidence and tenacity.	• Strategic competence (UNESCO, 2017; Wiek et al., 2011) • Showing initiative, taking command, autonomy and self-directed action (Trilling & Fadel, 2009; OECD, 2019; Barrie, 2006) • Change-orientation / driving change (Bammer et al., 2023; Jordan et al., 2021) • Ethical, social and professional accountability (Jackson, 2014; Barrie, 2012; Trilling & Fadel, 2009) • Global citizenship (Barrie, 2012; Voogt & Roblin, 2012) • Critical stance (UNESCO, 2017) • Action competence (Lans et al., 2014) • Agency beliefs (Ahvenharju et al., 2018)

Students learn to navigate complexity through radical openness and collaboration, relational and integrative thinking, creative inquiry, and an appreciation of plurality, which enables them to engage with uncertainty, conflicting perspectives, and emergent knowledge in real-world contexts (Adams & Maguire, 2023; Mascolo, 2023; Montuori, 2010). These aspects are relatively absent in mainstream education dominated by the utilitarian and value-neutral 'lifelong learning' frame.

Similarly, while traditional notions of teamwork and collaboration capabilities, widely featured in the literature, can be considered part of relationality and reflexivity, transdisciplinarity reframes these capabilities through pluralism and intrinsic holism (Bammer et al., 2023; Baumber, 2022; Le Hunte, 2021; McGregor, 2017; van der Bijl-Brouwer, 2022). Pluralism encourages students to recognise that all disciplinary perspectives are partial and incomplete (Repko et al., 2019), promoting meta-communal norms such as equity, rigour, coherence, and consistency, through engagement in participatory context-specific practices (Healy, 2003). In our transdisciplinary education programs, students from up to 27 different degrees across eight faculties work in multidisciplinary teams to tackle real-world challenges. Each student is encouraged to bring their unique disciplinary expertise while teaching staff from diverse backgrounds guide discussions on how different disciplines might approach the same issue (Baumber et al., 2024; Kligyte et al., 2024). External partners play a key role in shaping challenge briefs, offering practical and contextual guidance, with students also prompted to explore their lived experiences and factors such as age, gender, ethnicity, disability, and religion to ensure a broader, more inclusive understanding of the issues being explored (Allen et al., 2025; Baumber, 2022; Kligyte et al., 2022; Kligyte et al., 2024). Through these types of reflective, experiential and embodied learning approaches, students connect personal values and experiences to action, fostering creativity, collaboration, and knowledge integration to support societal transitions (Allen et al., 2025; Brown, 2018; Le Hunte et al., forthcoming). Throughout their transdisciplinary learning journey, students are also encouraged to evaluate the broader impacts of their projects, considering social, environmental, and ethical dimensions alongside disciplinary goals.

While systems and futures thinking as well as values-informed capabilities feature in the majority of sustainability-oriented competency frameworks (Redman & Wiek, 2021; Rieckmann, 2012; UNESCO, 2017; Wiek et al., 2011), they often lack the

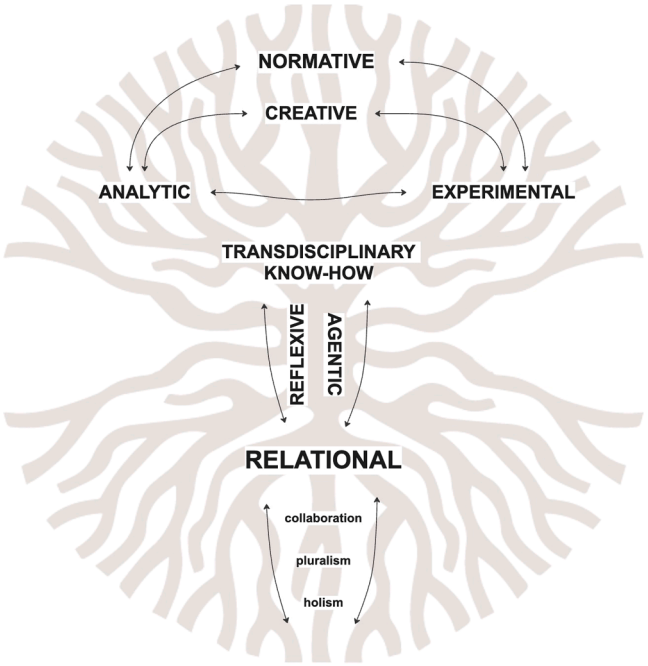

Fig. 1. Transdisciplinary future-making capability framework.

creative, experimental and integrative capabilities, which we deem to be essential to future-making (Le Hunte, 2021; Le Hunte et al., forthcoming; van der Bijl-Brouwer, 2022). In education literature, values orientation is typically expressed through dispositions and attitudes, for example, as 'global citizenship' in the 21st century capabilities frameworks (Voogt & Roblin, 2012), 'ethics and responsibility' in employability literature (Jackson, 2010), and environmental 'attitudes' in education for sustainable development (UNESCO, 2017). However, the link between having relevant affective dispositions and taking action toward sustainable and equitable futures is often unclear (Marcinkowski & Reid, 2019). Through an emphasis on exercising these affective dimensions, our transdisciplinary education practice highlights the crucial role of creating, experimenting, and acting in achieving desirable change (Allen et al., 2025; Le Hunte et al., forthcoming; Baumber, 2022; Lawrence, 2024b). There are strong similarities with entrepreneurship competencies in terms of the emphasis on agency and self-efficacy beliefs resulting in doing and acting (Lans et al., 2014), but transdisciplinary capabilities also incorporate relational and complexity components, which are not always evident in entrepreneurship, where the goals might be simpler.

Transdisciplinary capabilities can be developed and enacted through futures thinking and approaches. For example, analytic capability might involve horizon scanning, trend analysis, as well as modelling and scenario generation. Creative capability can be used to play with alternative rules and procedures, resulting in different future visions, original insights and viable new ways of thinking, products and services that are of value to others. Experimental capability is required in scenario development, experiential futures, and other participatory approaches that engage stakeholders in exploring and evaluating future possibilities. Normative capability guides the development and assessment of proposals for 'preferable' futures, advocating for desired outcomes. Relational capability emphasises intergenerational awareness and fostering relationships across different contexts, while reflexive capability supports social learning and transition processes. Finally, agentic capability empowers individuals to catalyse and sustain change, promoting optimism and proactive engagement with future possibilities. Importantly, transdisciplinary future-making capabilities highlight the relational and embedded aspects of learning, in contrast to approaches like 'futures consciousness' that prioritise psychometric testing of individuals (Ahvenharju et al., 2021; Ahvenharju et al., 2018) or 'futures literacy', which advocates for universally applicable skills that everyone should acquire (Miller, 2018).

We believe traditional higher education approaches can be enriched through a transdisciplinary dimension. Evidence suggests that graduates equipped with transdisciplinary future-making capabilities are highly sought after by employers. For example, Australian Graduate Outcomes Survey indicates that graduates of our transdisciplinary programs have 93 % employability rate (UTS, 2024), compared to 79 % nationally. While this outcome aligns with the economic vision of higher education, we argue that transdisciplinary education goes beyond merely preparing 'job-ready' graduates as individuals who can fit into the predetermined futures. By cultivating a relational, critical, and experimental imagination (Facer, 2022) —enabling students to question dominant assumptions, engage meaningfully with others, and co-create alternative futures—transdisciplinary education can position university graduates as active contributors to social value and transformative change (Király & Géring, 2021).

8. Concluding remarks

This paper makes two key contributions to futures, higher education and transdisciplinary scholarship and practice. First, it proposes a Transdisciplinary Future-making Capabilities Framework developed through reflexive engagement with both literature and our education practice. Grounded in a relational and contextualised concept of capabilities, it presents an expansive view of the capabilities required to create desirable futures. Our transdisciplinary sensemaking approach integrates capabilities associated with sustainability, employability, and innovation, while also encapsulating the contextual aspects of future-making and action.

Second, this exploration emphasises the transformative potential of transdisciplinary education. Through engagement with complexity, diverse perspectives and different time horizons, transdisciplinarity can act as a catalyst for redefining conventional approaches to higher education. At the same time, it invites critical reflection on the dominant discourses shaping these efforts. For example, 21st-century capabilities may simply be valued for their contribution to a creative, innovative and productive workforce, in line with the prevailing economic imaginary. In contrast, the notion of transdisciplinary future-making capabilities shifts the emphasis toward empowering graduates to actively transform political, economic and organisational systems in pursuit of equitable and sustainable futures, rather than simply adapting to or repairing the existing systems.

Building on this reflexive exploration, we invite further research and dialogue among futures scholars and practitioners. While this paper focuses on the educators' perspective, there is a need to investigate how graduates sensemake of their transdisciplinary future-making capabilities and apply them in practice to promote sustainable and equitable futures. Future research could engage students, alumni, and partner organisations to explore which capabilities are seen as necessary and desirable in different contexts. Questions around the long-term impact and value of these capabilities are also of interest. Finally, comparisons with others aimed at preparing learners for uncertain futures, whether transdisciplinary or otherwise, would enrich our collective understanding of how education can drive systemic change.

CRediT authorship contribution statement

Susanne Pratt: Writing – original draft, Writing – review & editing, Conceptualization. **Bella Bowdler:** Project administration, Data curation, Writing – review & editing, Formal analysis. **Giedre Kligyte:** Writing – original draft, Methodology, Formal analysis, Conceptualization, Writing – review & editing, Visualization, Funding acquisition, Data curation. **Jacqueline Melvold:** Writing – review & editing, Project administration, Formal analysis, Conceptualization, Writing – original draft, Methodology, Data curation.

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Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author(s) used ChatGPT and Microsoft Co-pilot to improve language and readability. After using this tool/service, the author(s) thoroughly reviewed and edited the content and take(s) full responsibility for the content of the publication.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Giedre Kligyte reports financial support was provided by University of Technology Sydney. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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