

Chapter 11

Making Collective Learning Coherent: An Adaptive Approach to the Practice of Transdisciplinary Pedagogy



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11.1 Prologue

On a cool sunny spring morning, we set out from Canberra to drive the 400 or so kilometres to our Sustainable Rural Systems field trip destination in the Murrumbidgee Valley—three teaching staff and 35 students. We planned to meet a wide range of people in the Valley, including food producers, irrigation managers, industry organisations, park rangers, food processors. On board the buses were teachers and students from very different backgrounds including biology, human ecology, agriculture, history, geography, law, and political science. As we swung into Northbourne Avenue we made an impressive cavalcade of three mini-buses and a good old Aussie Ute (pickup truck). We had a lot of driving ahead of us—4 hours there and back, and many hours of driving between the farms, businesses, environmental reserves and offices we planned to visit in the four-day trip to explore different perspectives and approaches to land management and livelihoods in the Murrumbidgee Valley. But these many hours behind the wheel were not wasted. In fact, these vehicles afforded excellent teaching environments for us. The mini-buses were kitted out with sound ports to plug in various phones and iPods, so there was a constant sharing of, and commenting about, various music and tastes. Snacks and drinks made their way up and down the bus, and the talk and the jokes flew fast.

In addition, the front seat was dubbed the ‘Navigator’s’ seat, where duties ranged from navigating via the iPad and taking photos, to mobile phone communication with the other vehicles, but most importantly, it was a place to have a one-on-one

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tutorial with the driver. This position was regularly rotated so that all the students got this opportunity. If there was a group that wanted a similar consultation, they travelled in the ute, which afforded the possibility of a four- or five-way conversation. The buses, unlike a traditional classroom, acted as a “leveler” and boundary object, creating an environment where staff and students became fellow travelers, and equal partners in learning.

While generally the teaching staff did the bulk of the driving, the students also took their turns. There were jokes about relative driving skills and a light-hearted rivalry between the different bus “crews”. Rest stops allowed the opportunity for a quick game of soccer or a play on the local swings, plus the occasional foray into a supermarket for ingredients for the evening meal.

So, what might seem to have been many hours wasted driving became a learning space with many opportunities and affordances. These included time for one-on-one and larger group consultation and discussion about the field trip and key learnings, as well as a great opportunity for teaching staff and students to bond and reinforce a collective learning environment which was fun, light-hearted but productive. While field trips are a familiar learning environment for both students and teachers, reframing them in terms of adaptation for a more transdisciplinary pedagogy opens up greater possibilities and affordances, not just for content learning, but for the development of key life skills, including the ability to engage with uncertainty, complexity and diversity, develop relationships and trust, and to think creatively, logically, flexibly and critically (McGregor 2017). This is particularly relevant in our area of the curriculum, where we convened subjects on society and environmental change perspectives in the Anthropocene, and system based approaches to sustainability, particularly in rural and food systems contexts. In these cases, there are multiple possible realities and a variety of perspectives for problem framing which presents interesting challenges for teaching.

11.2 Introduction

The chapters in the first section of this book have described the growing and changing understanding of transdisciplinary collaborative research and its links with collective learning. There is an extensive literature on approaches to transdisciplinary education (for which there is no single pedagogy) (See: Klein 2018, Chap. 2 in this book). This literature emphasizes collective learning across disciplinary and practice boundaries, dealing with complexity, with an emphasis on active learning (See also Ross and Mitchell 2018, Chap. 4 in this book; Prior et al. 2018, Chap. 5, in this book; McGregor 2017). But this chapter draws primarily on our own experiences. The chapters in this section (on transdisciplinary learning (education) focus on the pedagogical issues arising from attempting to integrate transdisciplinarity into tertiary institutions. This chapter draws on our own collaborative experiences of research and teaching and provides a bridge to the next section on case studies.

For most university teachers, traditional disciplinary teaching is still relevant and appropriate. However, the process of shifting from traditional, discipline-based conceptions of pedagogy towards a more transdisciplinary approach requires adaptation of their thinking and practice, which flows through to the way in which they use and adapt learning spaces.

In this chapter, we identify four key adaptive shifts that we see as fundamental to this move towards transdisciplinary pedagogy (see Sect. 11.3). We have limited our focus to shifts at the micro scale of the classroom or learning space, rather than shifts at the faculty or institutional level. We do this to enable teachers and students to maintain or reclaim agency in the pedagogical process at the classroom or micro level. This is particularly important for learning outcomes, given that greater control over their environment is identified as a key success factor in student learning (Kaplan and Haenlein 2016).

Our focus on the micro context, which includes space, time, things and socialities, has been an emerging area of study in education (Fenwick et al. 2011) under the umbrella term of ‘sociomaterial’ that describes the ‘constitutive entanglement of the social and the material in everyday life’ (Orlikowski 2007, p. 1435). It is a holistic, multi-dimensional, systems-based approach, in which neither the material nor the social is studied in isolation. Instead, we view our pedagogical context as an assemblage or a gathering of people and things that combine to form a whole that is greater than and different to its parts. Treating the whole learning environment as a ‘sociomaterial assemblage’ allows us to consider the connections and relationships in a set of conditions that enable or constrain different forms of action and interaction.

11.3 Shifting from a Traditional to a More Transdisciplinary Pedagogy

The shift from traditional to transdisciplinary pedagogy has in our case meant drawing on a range of disciplinary areas such as ecology, human ecology, biology, anthropology, sociology, geography, education, organizational studies, psychology, art, history and agricultural science. Some of these are from our own academic backgrounds and others we have drawn on from the literature and also from invited speakers and, on field trips, the practitioners. It is even difficult for us to be clear about which disciplines we are combining, given that our primary focus is on the problem rather than disciplinary knowledge.

In our experience, the reality of transdisciplinary teaching and learning does not start from a blank slate. We inherit socio-material assemblages that are legacies from previous teaching environments. Considering these legacies enables us to gain insight into how, through adapting and melding these highly complex environments, we can provide the best possible learning experiences for our students.

The rate of change and innovation in the thinking of individual university lecturers can far outpace change at the faculty or institutional scale. For students, this can be perceived as an inconsistency between our espoused pedagogical goals and approaches, and the sociomaterial assemblages they are actually learning in. To recreate a sense of consistency necessitates a shift in both thinking and action. To illustrate this, we have chosen to focus on four key principle-based shifts from traditional to more transdisciplinary principles for research and education. These shifts are drawn from the principles for transdisciplinary practice identified by Clarke (2016) and they align with the shifts in pedagogy outlined by Mulcahy et al. (2015). The four principle-based shifts are:

1. the shift from a disciplinary foundation to a problem focus
2. the shift from a unified, hegemonic approach to foundational thinking (ontology and epistemology) to embracing a diverse, inclusive plurality of world-views
3. the shift from compartmentalization of knowledge, to knowledge co-production as a human and social process
4. the shift from traditional uses of space, time and things to new, more flexible and dynamic arrangements.

In a university setting these sorts of shifts are highly complex and multifaceted, with change taking place at different rates over semesters and years. Therefore, to aid in our explanation, we use a series of epistemic lenses, which we outline in the next section.

11.4 Epistemic Dimensions: Multiple Ways of Understanding the Shifts

Addressing the complex problems of the Anthropocene (frequently termed wicked problems) requires consideration of multiple perspectives. This idea of multiplicity is foundational to transdisciplinarity and collective learning. Brown and Harris (2014) have proposed that all humans are capable of multiple ways of understanding beyond what is normally seen as valid ‘in our specialised world’ (Hocking et al. 2015, p. 31). These different ways of understanding have been metaphorically described as different lenses, dimensions or doorways into the richness of the context being studied. Drawing on this literature we utilize five epistemic lenses to view the changes in socio-material assemblages from multiple perspectives. Each lens sheds a different light on each of the shifts.

Our lenses are:

- **The biophysical lens**, which has a focus on measurement, is a familiar form of understanding in academia. It describes the things we can see, feel, touch, hear and taste. It includes space, time and things.
- **The cultural lens** includes the assumptions, practices, understandings and expectations that we share with the various communities we are part of, and which may not be accessible to those from other groups.

- **The ethical (or values-related) lens** includes ideals, values, interests, principles, and standards.
- **The relational lens** is about our connections to the human and nonhuman actors in the system. It also relates to our sense of trust, loyalty, connection, leadership and conflict, and our sense of others.
- **The aesthetic lens** relates to perspectives on beauty and ugliness, on design and visions. It relates to the less tangible factors that contribute to human wellbeing, and other emotions such as happiness, hope, calmness, excitement and contentment. It also relates to the concept of ‘enlivenment’ (or ‘die Lebendigkeit’ as it was originally conceived in German), where humans seek to reconnect to their aliveness and creativity (and that of the world) and through the enlarged understanding of art as expressed by the artist Joseph Beuys, who proposed that every human being is an artist (Weber and Kurt 2015).

Using this multidimensional set of lenses helps us to examine the richness of the sociomaterial assemblages as a complex, interrelated whole. The dimensions do not define sociomateriality, but provide a framework within which to examine and learn about the assemblages under study. A multidimensional understanding also supports the co-creation of new ways of thinking, learning and acting to work with the complexity and diversity of the systems we are trying to adapt (in this case the classroom).

11.5 Making the Shift

Our experience of making the shift towards transdisciplinarity is similar to that of others in this book, and we refer the reader to explore other chapters for a deeper examination of the theoretical underpinnings of the concepts involved. Our choice of shifts also reflects a movement from deep, underlying (and often tacit) theoretical considerations, upward towards the more visible and physical aspects of learning spaces.

11.5.1 *The Shift from a Disciplinary Foundation to a Problem Focus*

Traditional higher education pedagogy has relied on transmitting disciplinary knowledge to students, with a focus on establishing an acceptable level of knowledge and understanding (McGregor 2017). Transdisciplinary pedagogy, on the other hand, focuses on the problem at hand, and on bringing to bear a broad spectrum of knowledge and understanding with which to tackle these problems. This is particularly so in the case of complex and wicked problems.

One hallmark of transdisciplinary research has been a shift in focus from narrow, disciplinary content concerns to a ‘problem-based focus, an interest in action, participatory approaches’ (Klein 2017, p. 10) and the tackling of ‘wicked’, ‘real-world’ problems (Gaziulusoy and Boyle 2013; Klein 2018, Chap. 2 in this book). A wicked problem is a complex problem that defies complete definition, and for which there can be no final solution, since any resolution creates further problems, and solutions are not true or false or good or bad, but the best that can be done at the time (Brown 2010, p. 4). This requires a significant shift in the form of learning that the problem-solver is likely to experience. Gardner (1991) describes this shift as a move from the traditional, scholastic learner to the person who is more broadly experientially skilled as well as being an expert.

This shift can create dissonance and confusion for some students, particularly those who are used to structured, discipline-based information gathering for exams later in the semester. These students expect certain content areas to be covered and flagged as important. In contrast, a problem focus encourages a collaborative exploration of the complexities surrounding the problem. This requires the students to create partnerships with each other and develop listening and synthesis skills. As a result, a strong connection develops between the students and the problem framing they are focusing on. For example, in our discussions about the complex challenges of the anthropocene, we engaged the students in discussions about a range of issues that connected strongly to the students’ experiences, for example, promoting the use of bamboo baskets rather than plastic bags, waste disposal in urban environments in different countries, energy sources and use across multiple cultures and landscapes.

In attempting to shift our pedagogy to align with this shift in focus, we have designed and experimented with different unit structures and activities. For example, we have used the current popularity and profile of games such as PokemonGo to illustrate the ways in which the affordances of the ubiquitous smartphone are significantly changing the way we relate to each other, and to our physical environment.

From a cultural perspective, our approaches necessarily move outside the usual protocols and expectations of disciplinary teaching. Because our classes included such a diverse range of cultural backgrounds (in all senses of the word), we used small group work and feedback sessions to enable students to share their perspectives, experiences and problem framings. In this way, we encouraged them to become increasingly self-organizing learners drawing on a wide range of learning experiences, both within and beyond the confines of the university.

Most importantly, from the aesthetic perspective, we focused on making the learning journey enjoyable and memorable. We focused on images and representations that the students could relate to—for example we based one session around the film *The Matrix*. We used the metaphors and story of the film to examine ontological and epistemological framing and the importance of tacit knowledge. We also introduced rich picturing and concept mapping to create visual representations and encourage the students to think collectively and creatively.

11.5.2 The Shift from a Unified, Hegemonic Approach to Foundational Thinking to Embracing a Diverse, Inclusive Plurality of World-Views

The most challenging shift is a fundamental one. Put simply, the shift towards trans-disciplinary thinking requires paradigmatic change. The shift from traditional to transdisciplinary approaches is a shift from a disciplinary focus (or focus on expertise) to a focus that is primarily on societal problems and complex systems. These problems are highly complex, change rapidly, have no simple or single solutions and are perceived differently by different people. In response, transdisciplinary teaching is shifting from a focus on creating disciplinary expertise to focusing on understanding and learning to tackle these problems using a range of academic and practice-based skills and experiences.

This shift also includes a move from a hierarchical and hegemonic way of thinking and acting towards a greater plurality of ontological and epistemological framings and towards understanding the world as a ‘meshwork of mutually transformative and meaningful relationships’ (Weber and Kurt 2015). The change in foundational thinking is the most difficult kind of change, and can be considered a deep leverage point in the process of change towards tackling the wicked problems of the Anthropocene (Abson et al. 2017; Meadows 1999).

One of the biggest challenges for the students was the loss of the certainty of right and wrong answers. Instead they were presented with uncertainty and ambiguity and a move away from the idea that scientific knowledge is somehow ‘better’ than other ways of knowing, to the idea that all knowledge is partial, plural and provisional, and that generating knowledge requires many auxiliary assumptions and is context dependent (Russell 2010).

In studying rural sustainability in the Murray-Darling Basin (in Australia’s south-east), we introduced the geography of the area through the Annales historians, examining the various layers of the Annales, including geography, geomorphology, sociology and particular events. We then added to the systems thinking, the framing of wicked problems and biophysical and ecological settings. During the field trip and guest lectures, we introduced the students to a range of different perspectives and approaches to land management, and encouraged them to engage with a plurality of views, including amongst themselves. As lecturers, we deliberately disagreed with each other on certain points (on the basis of our different disciplinary backgrounds and our varied and extensive life experience). We also did not expect to be always right. We used this as a means of departing from the traditional knowledge hierarchy in which the lecturer transfers knowledge to the student.

11.5.3 The Shift from Compartmentalization of Knowledge to Knowledge Co-production As a Human and Social Process

The third shift follows on from the second shift in foundational thinking, in that it is about a change in how we view knowledge (epistemology) and what we believe about what exists in the world and the nature of human beings in the world (ontology). For example, in the case of many of the natural sciences, the third shift includes a shift from a linear, reductionist, instrumental approach to research and learning, towards a more collective, reflective, reflexive approach that encompasses iterative process and positive engagement with tension as both constructive and creative. It also includes the addition of some of the contrasting paradigms and pedagogies of the humanities, arts and design; and it involves bringing together previously separated disciplines such as geography and history.

One aspect of this type of change is a shift in legitimacies (Tost 2011). In particular, it has raised questions about what is legitimate knowledge and who can legitimately be involved in its generation. Therefore, transdisciplinary pedagogy should reflect a more open and inclusive participation by all (but does not infer an ‘anything goes’ mode of operation). It implies a reduction in power asymmetries to allow for the inclusion of different worldviews or ways of understanding the content of the unit. This brings our ethical, values-related epistemic lens to the fore.

The shift in legitimacy is directly linked to changes in the patterns of social interaction which emphasize the relational lens. Transdisciplinary research into wicked problems has usually been linked to some form of participation and collaboration, either between different disciplinary experts, or amongst all the different knowledge cultures engaged in tackling the problem (Brown 2008). This entails a shift from individualistic, homogenous activity to collective heterogeneous activities and associated social interactions. The shift in the socialities of research also impacts on the status and privileged positions of disciplines and academics. Virtually all the chapters in this volume address this issue, and it is reflected in the book’s title, in which the word ‘collaborative’ implies some form of equality among those involved. In this section, we describe how we responded and adapted to the shifts in legitimacies and socialities in our undergraduate and postgraduate units.

The authors’ professional relationship goes back decades, and we have worked collaboratively for all that time. Initially, our roles were client and consultant, but from the first those roles were blurred, and every aspect of the design and application of organizational interventions was undertaken together in a close dialogue of equals. Consequently, we brought this collaborative approach to our joint teaching in more recent years. Our years of experience of collaboration also mean that much of our thinking has become normalized and tacit. We extended this to the tutors who joined us in the teaching team. They initially found this approach novel and challenging, but also empowering. This created a very positive team atmosphere with greater creativity and mutual support.

Part of our collaborative design was to create spaces for emergent ideas and activities, generated from our interactions with the students to create a collective learning environment. Therefore for us, collective learning occurs not just between the students, but also between us and the students. In particular, we allowed doubt and questioning through peer group interactions in order to elicit responses to a problem or concern. We did not attempt to constrain responses or predict all the ideas that might be generated. Therefore, we were often faced with new information that was not included in our original design.

This initially created a gap between more traditional expectations and the shift in approach. For example, some students interpreted this approach as being underprepared, which created a sense of unease regarding our legitimacy as experts. This was amplified when we deliberately disagreed with each other on a particular point, emphasizing our different disciplinary backgrounds. While some students felt we should have “worked out our differences before coming to teach the topic”, most found these disagreements entertaining and informative, and they gained an immediate insight into some of the contestations which are common between disciplinary fields. Finally, we invited students to disagree with us and present their own coherent arguments. We asked genuine questions of them and incorporated their answers into what we did next. This generally resulted in much greater coherence and vigour in our discussions.

This approach was generally in conflict with many of the tacit expectations about how learning activities should function, particularly for some of the older students whose memories of university were of a more traditional pedagogy. It is often assumed that the more senior an academic, the more knowledge and expertise and therefore status and respect they deserve. This creates a cultural hierarchy that places tutors on a lower rung and students a number of rungs below that. This legitimizes the knowledge of some over others and is amplified by the set-up of physical learning spaces.

As each unit progressed the majority of students came to enjoy the new social structure we had developed. One feature of the improved relationality was an increase in trust (Robbins 2016). We in turn learnt from the feedback from, and dialogue with, the students and tutors and with every repeat of a unit we redesigned and further developed our approach.

For us, a significant part of the early teaching period in each unit was a focus on building a picture of the group, and working to create a socially coherent learning environment. At the beginning of each semester, we engaged with the students in a mutual attempt to understand who we were as people and learners. What were the backgrounds, interests, motivations and values of those in the unit? What prompted them to enrol in the course? What expectations did they have? Using our epistemic lenses, we also enquired about their cultural backgrounds. Many of our students were international, coming from a wide range of countries and backgrounds. Cultural groupings also included different age groups (ranging from late teen undergraduates to mature age master’s students with extensive life and career experience).

Generally, our units included a four-day field trip. This not only provided a lived-experience approach to learning, it also allowed for building of relationships and connections between the students, encouraged by the need to work in groups. While during the day we visited farms, factories, environmental parks and facilities, in the evenings we mixed social interaction with feedback and discussion sessions. Staff and students stayed in bunkhouse accommodation and shared cooking and cleaning and evening social activities.

11.5.4 The Shift from Traditional Uses of Space and Time to New More Flexible and Dynamic Arrangements

Our final shift is the most visible and the one where we faced the most obvious constraints. It encompasses changes in the use of time, space, things and technologies. In our teaching units we attempted to amplify and embed the shifts in focus, knowledge and relationships through our use of the available material elements. So, in shifting materialities, we would describe our adapted pedagogy as making flexible arrangements of time, space and things. While this is not necessarily specific to transdisciplinary pedagogy, we argue that it becomes more urgent and essential in the transdisciplinary teaching context.

Time is one of the most tacit elements in a university. From the moment a student enrolls, time is divided into predictable patterns of lectures, tutorials, workshops and field trips. Life is subject to the rhythms of study, assessment and holidays. The administrative default setting for our units was an expectation of a 1-h lecture and a separate 2-h tutorial (often with multiple tutorial groups if the class was large) spread throughout the semester. In our case, we requested a weekly, single block of 3 h. This enabled us to break the time into short periods of monologue, dialogue, panel sessions and workshops, thus adding diversity to traditional formats. This was often in conflict with the expectations of many students who (under a more traditional format) often skip lectures and only come for tutorials. This was exacerbated by multiple timetable clashes between subjects. While we had limited agency to adapt to this, we responded by trying to include as much material as possible on the Moodle website (the e-learning online tool used by our university).

Along with the timeframes, we inherited both the spaces for learning and the furniture and technologies within them. A significant issue we experienced was the allocation of rooms at the beginning of the semester. In our case, for two semesters we were allocated a room quite late, well after other courses. This limited our choice, and resulted in spaces that were often suboptimal for the class size and difficult to utilize in a transdisciplinary manner.

A shift to a more transdisciplinary approach to learning requires a rethinking of even our most fundamental assumptions about learning spaces. Let's start with a seemingly simple question: what is a classroom? Reflecting on this question can bring to the surface many (often unconscious) assumptions held about learning and

teaching. It can also help us understand how the setting for learning and research affects us as educators and students. The term ‘classroom’ is a very common description of tertiary teaching spaces. We contrast this with the German term for a teaching space: ‘der Hörsaal’ which literally translated combines the nouns for ‘hearing’, and ‘room’ or ‘salon’, reinforcing the Medieval idea of students receiving or hearing the wisdom of their teachers (Mulcahy et al. 2015).

At our university (a relatively modern one), most of the teaching rooms are separate and enclosed, with lockable doors. Furniture in the rooms usually consists of a projector directed at a fixed screen on one wall for presenting, and chairs and/or desks, usually set out in rows facing the front, sometimes fixed in tiers, sometimes moveable. This layout reflects the historical origins of universities. Traditional university rooms are based on the medieval catholic mass. They reflect a hierarchy of ‘lecturer’ (reader) over the students (writers) as the knowledge is passed from the former to the latter (Park and Choi 2014, p. 750). After World War II, modernist architecture, based on efficiency, allowed greater numbers to fit in ‘lecture’ halls to have knowledge transmitted to them in a one-way flow (Dovey and Fisher 2014, p. 44).

In contrast to many universities, various high schools have been built with a design for ‘open plan’ classrooms where multiple classes share a single space. These buildings reflect a period in the 1970s of “architectural innovation linked to new pedagogies” (Mulcahy, et al. 2015), based on ‘constructivist’ ontologies and epistemologies. So the shift in school learning space design reflects the shift in pedagogical philosophy:

In this new constructivist thinking, where teachers serve as facilitators for active student engagement, where learning occurs in many locations, and where power is distributed across actors, learning space needs are seen to be far more dynamic and situational than they were under the transmission model. (Van Note Chism 2002, p. 10)

Learning spaces, then, can be seen as sociomaterial assemblages that enable and constrain different forms of interaction (Van Note Chism (2002) where the physical space is not neutral but has been designed for a particular form of learning. However, the original design and intent does not completely determine the uses to which these spaces are put, and we were able to adapt our inherited sociomaterial assemblages by reassembling the elements we could change in new ways. One way of adapting was by considering the ‘affordances’ of what we had to work with. Affordances are described as:

the physical properties of an object [that] make possible different functions for the person perceiving or using that object. In other words, the properties of objects determine the possibilities for action. (Dovey and Fisher 2014, p. 44)

The combined experience of the authors as educators ranging from kindergarten to postgraduate level teaching, as well as adult education, and it includes a host of different educational settings. In many cases we have had little choice about the place allocated to us for our learning activities. Usually we have had to operate in a standard ‘classroom’ or university ‘lecture theatre’ or ‘seminar room’. Beyond these more standard settings we have also ‘taught’ in massive halls, small hotel rooms, tin sheds, hallways, buses (see prologue), outdoor school benches, hilltops, paddocks,

fields, swamps, orchards, company boardrooms, top-secret facilities, shearing sheds, airport lounges, shacks, huts, and (our personal favourite) floating down a river on home-made rafts. Each has brought with it both constraints and affordances for different types of learning. Each is also situated within a larger temporal and spatial environment, with its own affordances and constraints.

Along with other objects, the affordances of technologies constrain and enable what is possible in a learning environment. In our case we have focused on technologies that support dialogue (Sellen and Harper 2003). These have included those things often found in university rooms such as whiteboards and projectors, but we have also used some things in less traditional ways. Windows have thus become places for post-it note brainstorming in small groups (p. 17) and whiteboards have become ‘boundary objects’ (Bohm 1996; Conklin 2005; Isaacs 1999) for students to explore and co-create ideas.

We have also introduced new technologies, including cameras on field trips and ‘keypads’ or ‘clickers’, a form of personal, anonymous, instant surveying technology that supported our early semester ‘getting to know each other’ activities. Another interesting development in technology has been the introduction of online tools for learning. In our case, the university uses the Moodle website, where readings, lecture notes, lecture recordings, assignments, and other resources are stored.

Finally, field trips contain many material affordances for time, space and things. For example, buses became relational, social spaces that supported the building of trust and offer opportunities for deep dialogue (Straker 1997). Which brings us back to our prologue and the buses (Fig. 11.1).



Fig. 11.1 Ever on the move: field trip buses as a prime example of adaptive sociomaterial assemblages for collective learning. (Photo by Craig Ashhurst 2011)

11.6 Conclusion: Reflecting, Dealing with Tension and the Next Cycle of Learning

In this chapter, we have outlined our approach to adapting the learning spaces we inherited. Our description of this approach has been presented under four key shifts: disciplinary to problem focus; from a unified, hegemonic approach to foundational thinking to embracing a diverse, inclusive plurality of world-views; compartmentalization to co-production of knowledge; and the shift away from traditional uses of space, time and things. To address and work with complexity, we used multiple perspectives to understand and adapt these learning spaces by using five epistemic lenses (biophysical, cultural, ethical, relational and aesthetic).

The process of change and the variations in the pace at which various elements change create incoherences, uncertainty and tension between conflicting realities. Dealing with this requires the adoption of additional principles of reflection and reflexivity, a willingness to engage positively with tension and incoherence, and an iterative approach to adaptation that should also be transparent to the students.

This process of adaptation within complexity and of tackling wicked problems is a key part of the learning for students of transdisciplinarity. Therefore, we have been transparent about the realities of change, particularly in the Anthropocene. In many cases, the rhetoric of transdisciplinary teaching lags behind the reality. If the teaching approach used is based on disciplinarity and content-focused individualistic learning, it doesn't matter how innovative the teaching space is, it can still lead to a sense of pedagogical incoherence for the students where there is a lack of correspondence between the lived experience of learning and the expectations and theoretical framing. Like the buses in our prologue, there is constant movement and change, which is incorporated into the transdisciplinary learning experience, and teachers and students become fellow adaptive travellers in our rapidly changing world.

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References

- Abson, D. J., Fischer, J., Leventon, J., Newig, J., Schomerus, T., Vilsmaier, U., et al. (2017). Leverage points for sustainability transformation. *Ambio*, 46(1), 30–39. <https://doi.org/10.1007/s13280-016-0800-y>.
- Bohm, D. (1996). *On dialogue*. New York: Routledge.

- Brown, V. A. (2008). *Leonardo's vision: A guide to collective thinking and action*. Rotterdam: Sense Publishers.
- Brown, V. A. (2010). Collective inquiry and its wicked problems. In V. A. Brown, J. A. Harris, & J. Russell (Eds.), *Tackling wicked problems: Through the transdisciplinary imagination* (pp. 1–13). London: Earthscan.
- Brown, V. A., & Harris, J. (2014). *The human capacity for transformational change: Harnessing the collective mind*. New York: Routledge.
- Clarke, E. A. (2016). *The synergies of difference: Strengthening transdisciplinary research practice through a relational methodology*. Canberra: The Australian National University.
- Conklin, J. (2005). *Dialogue mapping: Building shared understanding of wicked problems*. Hoboken: Wiley.
- Dovey, K., & Fisher, K. (2014). Designing for adaptation: The school as socio-spatial assemblage. *The Journal of Architecture*, 19(1), 43. <https://doi.org/10.1080/13602365.2014.882376>.
- Fenwick, T., Edwards, R., & Sawchuk, P. (2011). *Emerging approaches to educational research: Tracing the sociomaterial*. London: Routledge.
- Gardner, H. (1991). *The unschooled mind: How children think and how schools should teach*. New York: Basic Books Inc.
- Gaziulusoy, A. I., & Boyle, C. (2013). Proposing a heuristic reflective tool for reviewing literature in transdisciplinary research for sustainability. *Journal of Cleaner Production*, 48, 139–147. <https://doi.org/10.1016/j.jclepro.2012.04.013>.
- Hocking, V. T., Brown, V. A., & Harris, J. A. (2015). Tackling wicked problems through collective design. *Intelligent Buildings International*, 8(1), 24–36. <https://doi.org/10.1080/17508975.2015.1058743>.
- Isaacs, W. (1999). *Dialogue and the art of thinking together: A pioneering approach to communicating in business and in life*. New York: Bantam Doubleday Dell Publishing Group.
- Kaplan, A. M., & Haenlein, M. (2016). Higher education and the digital revolution: About MOOCs, SPOCs, social media, and the Cookie Monster. *Business Horizons*, 59(4), 441–450. <https://doi.org/10.1016/j.bushor.2016.03.008>.
- Klein, J. T. (2017). Transdisciplinarity and sustainability: Patterns of definition. In D. Fam, J. Palmer, C. Riedy, & C. Mitchell (Eds.), *Transdisciplinary research and practice for sustainability outcomes*. London/New York: Routledge.
- Klein, J. T. (2018). Learning and transdisciplinary collaboration: A conceptual vocabulary. In D. Fam, L. Neuhauser, & P. Gibbs (Eds.), *The art of collaborative research and collective learning: Transdisciplinary research, practice and education*. Dordrecht: Springer.
- McGregor, S. (2017). Transdisciplinary pedagogy in higher education: Transdisciplinary learning, learning cycles and habits of mind. In P. Gibbs (Ed.), *Transdisciplinary higher education: A theoretical basis revealed in practice* (p. 3015). London: Springer.
- Meadows, D. (1999). *Leverage points: Places to intervene in a system*. Hartland: The Sustainability Institute.
- Mulcahy, D., Cleveland, B., & Aberton, H. (2015). Learning spaces and pedagogic change: Envisioned, enacted and experienced. *Pedagogy, Culture & Society*, 23(4), 575–595. <https://doi.org/10.1080/14681366.2015.1055128>.
- Orlikowski, W. J. (2007). Sociomaterial practices: Exploring technology at work. *Organization Studies*, 28(9), 1435–1448.
- Park, E. L., & Choi, B. K. (2014). Transformation of classroom spaces: Traditional versus active learning classroom in colleges. *Higher Education*, 68(5), 749. <https://doi.org/10.1007/s10734-014-9742-0>.
- Prior, J., Cuzac, C., & Capon, A. (2018). The role of pliability and transversality within transdisciplinarity: Opening university research and learning to planetary health. In D. Fam, L. Neuhauser, & P. Gibbs (Eds.), *The art of collaborative research and collective learning: Transdisciplinary research, practice and education*. Dordrecht: Springer.
- Robbins, B. G. (2016). From the general to the specific: How social trust motivates relational trust. *Social Science Research*, 55, 16–30. <https://doi.org/10.1016/j.ssresearch.2015.09.004>.

- Ross, K., & Mitchell, C. (2018). Chapter 4: Transforming transdisciplinarity: An expansion of strong transdisciplinarity and its centrality in enabling effective collaboration. In D. Fam, L. Neuhauser, & P. Gibbs (Eds.), *The art of collaborative research and collective learning: Transdisciplinary research, practice and education* (pp. x–xx). Dordrecht: Springer.
- Russell, J. (2010). A philosophical framework for an open and critical transdisciplinary inquiry. In V. A. Brown, J. A. Harris, & J. Russell (Eds.), *Tackling wicked problems: Through the transdisciplinary imagination* (pp. 31–60). London: Earthscan.
- Sellen, A. J., & Harper, R. H. R. (2003). *The myth of the paperless office*. Cambridge, MA: MIT Press.
- Straker, D. (1997). *Rapid problem solving with post-it notes*. Hampshire: Gower Publishing.
- Tost, L. P. (2011). An integrative model of legitimacy judgments. *Academy of Management Review*, 36(4), 686–710. <https://doi.org/10.5465/amr.2010.0227>.
- Van Note Chism, N. (2002). A tale of two classrooms. *New Directions for Teaching and Learning*, 2002(92), 5–12. <https://doi.org/10.1002/tl.74>.
- Weber, A., & Kurt, H. (2015). Towards cultures of aliveness: Politics and poetics in a postdualistic age, an Anthropocene manifesto. *Solutions*, September–October 2015.