Paul Gibbs *Editor*

Transdisciplinary Higher Education

A Theoretical Basis Revealed in Practice

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Preface: Why We Need to Be Transdisciplinary

This book is not just about thinking or acting in transdisciplinary ways, but about being transdisciplinary. To achieve this requires a deconstruction of our current way of acting within the definition of being that others impose upon us. Transdisciplinarity is a phenomenological perspective of reality and its manifestation in the world in which we exist. In this sense, it is a disjunction from the disciplinary, or multi- or interdisciplinary, approaches to our being in the world. I rather think that it is the primordial way of being that shatters both the hegemonies of the knowledge of the powerful and their interpretations of how the world should be seen. It is a reclaiming of that which is essential the being of Being, stripped of limits set by professions, disciplines and morality. Transdisciplinarity is an onto-epistemological approach to the world. It seeks to change and to understand, not to observe and comment, while recognising the value that these activities can bring to the reality of our transdisciplinary world.

This is not to argue that the methods of defining our world have not produced important improvements to the physical existence of our lives (at least, if you dwell in a Western neo-post-industrial state), for life has certainly improved there in terms of spending power and health. But even here, we should ask the question: at what price has been the enframing of our being in disciplines, their methodologies and their thinking to our understanding of the world of pleasure and pain, of privilege and deprivation and of power and subservience? This book is being published at a time of enormous inequalities in the world, driven by a neoliberal model of capitalism that sees the rich becoming richer and the poor, well, poorer. War rages and innocence dies. Natural disasters engulf communities, states and countries, and we, for the most part, just look on in a sense of helplessness. We see resourcefulness and the extent of their imaginable use blocked by convention and tradition.

Transdisciplinarity can remove the excuses of seeking first to define cause and effect or reductionism or constraint. Transdisciplinarity helps us to see phenomena for what they are, not what can be made of them and not how we can package them to satisfy the need of those who conditionally will to intervene, but to see the reality of those who suffer as real, not virtual. When such realities are revealed, they leave

no hiding places and no comfort zones to observe the work, just a calling to bring humanity forth to be and to emerge.

What About the Book?

The book's purpose is to contribute to our understanding of transdisciplinarity in higher education, its pedagogy, structure and governance. The book consists of a collection of chapters, the core being developed from a recent international symposium at Middlesex University, with additional commissioned contributions from the global academic community. The assembled writing team draws on world-acclaimed experts in transdisciplinary pedagogy, curriculum thought and practice from Europe and the USA, featuring scholars from some of the most important teaching and research institutions engaged in transdisciplinary practice. With an emphasis on higher education praxis, it presents a range of perspectives that reflect uniquely upon the higher education sector and attempt to weave a path of intellectual challenge, questioning and practical exploration of higher education practice. The aim is also to raise awareness and disseminate good practice among researching academics and to provide a text to serve as a resource for master's and doctoral students, as well as for academics.

Throughout the book, contributors make creative and innovative contribution to the literature and build on the work of others in the field. They necessarily build on the works of Gibbons, Limoges, Nowotny, Schwartzman, Scott and Trow (1994); Nicolescu (2002); Pohl and Hadorn (2007); Brown, Harris and Russell (2010); and Gibbs (2015) and their subsequent works. Notions of Nicolescu's 'hidden third', Brown et al.'s 'wicked problems' and Pohl and Hadorn's 'contextualisation' are used without further consideration in a number of chapters as acknowledged concepts in the discussion of transdisciplinary studies, and this reflects the major achievements of these authors (and, for those who are unfamiliar with the ideas embodied in these concepts, the references at the end of this chapter may help). There is also a tendency to assume that principles of transdisciplinarity are a social good. This is not a requirement of the approaches discussed here, yet is often a consequence of the type of problems that present themselves as worthy of transdisciplinary investigation – big, social and important issues – that other forms of disciplinary investigation are unable to solve.

Specifically, Why Higher Education?

This book seeks to develop a widely based transdisciplinary understanding of the issues faced by higher education institutions and those who work within and with these institutions. It will incorporate international contributions from organisational theory, anthropology, history, psychology, social sciences, philosophy and

practitioners to create a volume that will make an important and distinct contribution to the literature on higher education. The subject area and the structuring of the book fill a gap, and the insights in the book offer rich grounds for further research and make a distinctive contribution to the literature.

Higher education has shifted from being a privilege for the rich and extremely bright to a right for all those able to attend. The nature of education is certainly being commercialised, both in its provision and in its curriculum content, but is it remaining relevant to the problems that societies face? The loss to civic society from such a nihilistic drift is barely discussed in terms other than the void between those who attend university and those who do not. This book intends to lift the debate and explore how we perceive transdisciplinarity, as it might shape the practices of those involved in higher education in terms of knowledge generation, teaching and learning policy and its temporal horizons and content.

This is the first time that a comprehensive and serious attempt has been made to understand, reflect and comment on the issues of transdisciplinarity in higher education. Higher education might rapidly lose its potency in the economic realities of the twenty-first century unless it finds ways to respond to the critical and often non-disciplinary concerns of society. This change, driven by economic, political and a growing globalisation of opportunity, provides the book's context. It brings together transdisciplinary theorists and practitioners of higher education from across the world to discuss the concerns facing higher education and its global communities. The contributors have all published previously on the topic, and, together, they represent a wide of opinion and practice that offers the reader the experience of scholars working at the cutting edge of the praxis of transdisciplinary higher education.

Structure

The book has four integrated sections. The classifications are, as one would expect in a transdisciplinary book, permeable. They share neither a uniform tone nor an internal structure, but report on theory and practice through personal reflection, voices and case studies. They were written to give a wide appreciation of the transdisciplinary higher education within four broad pillars of emergent praxis.

The first – *Pedagogical Perspectives on Transdisciplinarity* – contains four chapters from a range of perspectives, but with a focus on the philosophical through a common lens of higher education. It is contemporary and explores conceptual ideas of pedagogies, curriculum and thinking. Within this section, four world authorities on transdisciplinarity pedagogy, curriculum and higher education make significant contributions. Sue opens the book and advocates a form of pedagogy transcending disciplines in a collective and collaborative way, co-producing solutions and knowledge. Jon offers a different position on pedagogy, turning to the hermeneutical approach of Gadamer for inspection. This enriches the book's discussion on pedagogy and extends our inquiry into the indeterminate and the imaginary. Exploring Gadamer frames transdisciplinarity in a novel and important way. David focuses on

the higher education curriculum before examining the two key epistemic notions of interdisciplinarity and transdisciplinarity. He develops a discussion on the nature of knowledge. In the final contribution of the section, Paul takes up the challenge of thinking on transdisciplinarity. This leads him to advocate a more poetic way of thinking about our transdisciplinary being.

The second section – *Contexts for Transdisciplinary Educational Practice* – places transdisciplinarity in the context of practice in higher education. Distinguished scholars contribute six chapters dealing with undergraduate and postgraduate teaching, learning and research. The contributions offer insight from established centres of transdisciplinary learning in the UK and the USA.

The first contribution is from Barbara, a senior academic practitioner and manager, who discusses approaches to postgraduate research education. She not only advocates transdisciplinarity but proposes a form in which it might flourish within an institutional setting. This chapter is followed and contrasted by an outline of undergraduate transdisciplinarity in undergraduate engineering education in the USA by Helen, KelliLynn and Atila. Their chapter not only seems to develop more competent and employable engineers, but those who can understand the complexity of social problems and the need for complex solutions.

We return to the UK for an account of a 3-year research project on counterterrorism and the interconnectivity of architecture and crime science. Hervé and Daniel discuss how their experience may lead to a new curriculum for architects that is better able to respond to contemporary society. We return to graduate education and the USA, from where Patricia presents a case study of transdisciplinary graduate education. In this fascinating chapter, we learn of the transition of a university through its rationale and its institutional implementation to the realisation of a goal of respecting disciplines, yet finding new and innovative ways of dealing with world problems. The penultimate contribution is from Vida who, through her reflections, opens ways of seeing dance. Her premise is that dance as improvisation has a significant role to play in how we come to understand knowledge as embodied, emergent and transdisciplinary in mode of education.

The chapters in this section so far are varied and deal with undergraduate and postgraduate education, in the forms of disciplinary transcendence and the exploration of embodied learning. The final chapter turns to the development of academics themselves. In her chapter, Carole considers ways in which educational developers in higher education might adopt a transdisciplinary perspective in how they work with academics on their teaching skills.

The third section – *Issues Relating to Transdisciplinarity* – is about debate, critique and developing ideas. This is a section to be cherished, for it is about our futures (and our pasts). It is opened by a leading world thinker on the subject, Basarab. His challenging chapter extends his thinking and writing, which has established such notions as the hidden third. His introduction of the notion of three barbarisms – ontological, logic and epistemological – opens a space for debate that is uniquely Nicolescuian. The voice of anthropology is spoken by Kate, whose insightful framing of transdisciplinary learning also forces readers to reconsider the

way in which they see the world. She suggests that if universities are to be influential in our complex and globalised world, they need to open up to the possibilities of other ways of thinking and doing than they currently generally embrace.

Brett sees an intertwining of the separation of knowledge into either the arts or sciences. He engages with developing a workable aesthetic framework for the entering practices of art and science and how a transdisciplinary approach would influence our understanding of the scientific imagination through the utilisation of metaphor. The concluding chapter in this section is provided by Ifan, who takes a critical stance on the notion of transdisciplinary education. From the perspective of a business school professional doctorate, Ifan argues for appropriateness and choice in the forms of investigation pursued. His chapter offers the break that we need to re-evaluate the place for transdisciplinarity in our academic world and its engagement with students. Taking time to stop and think can only enrich our ways of acting in the world, and this is a worthy reminder for us to do so.

The fourth and final section bears the title of the final chapter – *How to Build Bridges*. It does so because the contribution is powerful and distinctive and helps to set the book apart from others. It presents stories of those who have been influenced by inter-, cross- and transdisciplinarity and who reflect on how their own lives and careers have been influenced. The chapter is led by Kenneth, supported by five eminent colleagues, Arthur, Margaret, Conevery, Maria and Jungah. Their fascinating and unique pictures of being transdisciplinary contribute a distinctive feature of the book and are worth reading at any time including as first you read.

The experience of compiling this book has been surprising, uplifting and satisfying. The range of content within it, and the often complementary ideas and thinking counterpointed to the different approaches, make the book stimulating and, I hope, enjoyable. It does, I think, reflect important issues for higher education, its epistemological practices and its place in the world. The book is to be used as the reader defines. Each chapter stands alone, yet contributes to its section and to the overall shape of the book. Dip in anywhere, and there ought to be something of interest or controversy to reward your effort.

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Contents

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Paul Gibbs is director of education research at Middlesex University. He is a professor of the university, founder of the Centre for Education Research and Scholarship and an honorary research fellow at the Open University in Hong Kong and the University of Cyprus. He is an educator and researcher, having taught notions of transdisciplinarity alongside social realism and Heideggerian hermeneutics, and has over 30 successful transdisciplinary professional doctorate students. He has published 20 books on topics ranging from the marketing of higher education to vocationalism and higher education and has published more than 80 academic articles. His particular approach to transdisciplinarity that informs his work is through the works of Heidegger, neo-Confucian thought and the insights of Basarab Nicolescu. He is also the series editor of *SpringerBriefs on Key Thinkers in Education* and *Debating Higher Education: Philosophical Perspectives* for Springer Academic Press.

Heather Greenhalgh-Spencer PhD is assistant professor in the Department of Curriculum and Instruction at Texas Tech University. Her research emerges at the intersection of educational technology, diversity and equity issues and global studies. She is particularly interested in the ways that embodiment, materiality and glocal forces shape the ways that we think about, use and learn with digital technologies. She draws on philosophies of technology, curriculum theory and pedagogical praxis as she explores the ways that digital technologies can create access to learning and push against oppressive binaries and ideologies. Greenhalgh-Spencer explores practices of using technology and new media to create engagement in learning in both formal and informal learning spaces. She explores diversity and equity issues in the STEM pipeline and also researches pedagogical practices that increase engagement for under-represented populations in STEM courses, such as transdisciplinary engineering. She also researches embodiment pedagogies and the use of digital devices for personalised learning. Dr. Greenhalgh-Spencer has published in multiple international journals of education. She teaches courses on e-learning, personalised learning pedagogies, diversity ideologies and policies and educational philosophy.

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anthropological approaches can contribute to conceptualising and theorising professional practice, including ethnography, storytelling, metaphor, translation and the agency of the individual in cultural ecologies. She has given papers and written on transdisciplinarity, aligning it to anthropology, and its relevance to the contemporary pursuit of answers to complex micro- and macro-problems. She was drawn to work-based learning for the same reasons that she remains informed by anthropology and engaged in transdisciplinarity: its stance on the contribution of practice to knowledge and its role in creating the conditions for a more equitable share in decision-making processes to improve the societies in which we live.

Sue L.T. McGregor is professor emerita and is a Canadian home economist (over 45 years), recently retired from Mount Saint Vincent University, Halifax, Nova Scotia. She was one of the lead architects for the interuniversity doctoral programme in educational studies, serving as its inaugural coordinator. She has a keen interest in home economics, philosophy, transdisciplinarity and consumer studies. She is a TheATLAS Fellow (transdisciplinarity), a docent in home economics at the University of Helsinki, a Marjorie M. Brown Distinguished Professor (home economics leadership) and a Karpatkin International Consumer Fellow, and she received the TOPACE International Award (Berlin) for distinguished international consumer scholarship. Affiliated with 20 professional journals (as editor, coeditor, associate editor and board member), she has written 160 peer-reviewed publications, 60 book chapters, ten monographs and four books. She has delivered 27 keynote presentations and been invited to join talks in 12 countries. Dr. McGregor is principal consultant for the McGregor Consulting Group (1991): http://www.consultmcgregor.com, sue.mcgregor@msvu.ca.

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Brett Wilson is a former professor of electronics and communications and industrial consultant who took early retirement and became a 'scientist in residence' in a Department of Art and Design, where he taught research methods to practice-led postgraduate arts researchers. He co-founded 'Project Dialogue' in 2006 to help to promote better understanding across research in the arts, sciences and humanities and is lead editor of *Art, Science and Cultural Understanding*, published in 2014. He is currently professor of graduate education (part-time) in the Faculty of Science and Engineering at the University of Manchester. His present research interests are in trying to formulate a clearer understanding of the role played by non-literal language in the formation of scientific concepts and developing an aesthetic framework for transdisciplinary ArtScience practice and theory.

Part I
Educational Perspectives on Transdisciplinarity

Chapter 1
Transdisciplinary Pedagogy in Higher Education: Transdisciplinary Learning, Learning Cycles and Habits of Minds

Sue L.T. McGregor

This book seeks to enhance understandings of transdisciplinarity in higher education, its pedagogy, structure and governance. This chapter homes in on transdisciplinary (TD) higher education pedagogy. In most instances, higher education pedagogy tends to focus on transmitting disciplinary knowledge and learning. Disciplinary knowledge is substantive knowledge accrued by a discipline. Substantive knowledge comprises both (a) complex concepts that are essential to understanding a subject, and (b) second order concepts that underlie the practice of making sense of the *substance* of the discipline. Using the history discipline as an example, complex concepts include monarchy, constitutions and slavery. Second order concepts would include cause and consequence, change and continuity, empathy, the nature of historical accounts and evidence, and what counts as significant in history (Donovan & Bransford, 2005).

If higher education students are fortunate, they will experience more than disciplinary learning and be exposed to multidisciplinary learning (more than one discipline, with no integration), and interdisciplinary learning (between disciplines, with integration). All of these approaches remain confined to disciplines, excluding other ways of knowing. Transdisciplinarity pushes the boundaries of these three approaches to include both higher education (mono, multi and inter-discipline) *and* larger society (government, industry, citizens and civil society). TD pedagogy helps students to learn to co-create, co-disseminate and co-use transdisciplinary knowledge, which emerges from the iterative interactions between disciplines and the rest of the world.

This chapter explores what might comprise a transdisciplinary pedagogy in higher education. After describing the traditional intents of higher education, the conversation turns to how these must change in order to prepare graduates for the profound complexity of the contemporary world. A canvass of the nascent literature

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Fig. 1.1 Three overarching transdisciplinary learning ideas

on transdisciplinary pedagogy revealed three large ideas that merit consideration by higher education curricula planners: (a) transdisciplinary learning (compared to disciplinary learning), (b) the transdisciplinary learning cycle, and (c) transdisciplinary habits of mind (see Fig. 1.1).

1.1 Higher Education

Higher education is a term that refers to the level of education beyond high school (or its equivalent). It is provided at universities, academies, seminaries, professional schools and institutes of technology. It is also provided at college-level institutions, including junior colleges, trade schools, vocational schools and career colleges. It is called higher education, because formerly it referred to students who went higher than primary education. Also called higher learning, post-secondary education and tertiary learning, higher education can involve Bachelor, Masters and/or doctoral degrees, as well as post-doctoral studies. Technical schools offer associate degrees, diplomas and certificates (Bruffee, 1998; Wikipedia Encyclopaedia, 2016).

Higher education is so much more than helping graduates to obtain gainful employment and become meaningful contributors to the global economy. Higher education also exists to share existing knowledge, and to create and disseminate new knowledge (especially through research). It strives to help learners to develop higher-order cognitive and communicative skills, including but not limited to thinking logi-

cally, flexibly, critically and creatively. They should also learn complex reasoning, complexity thinking, integrative thinking, and problem posing and solving. Ideally, higher education teaches deep learning for life (Chan, Brown, & Ludlow, 2014).

Students attending higher education institutions should also become motivated to challenge the status quo of the world. They should be socialised to see themselves as a new generation of global citizens who care about the world (i.e. people, other species and the environment). In concert with this, higher education should inculcate a more sophisticated value system, comprising civic courage with a strong sense of autonomy and self, moral authority, global awareness, responsible citizenship and a purpose in life that extends beyond themselves (Chan et al., 2014). The foundational knowledge gained in higher education circumscribes students' lives; they never entirely outgrow this knowledge (Bruffee, 1998). That is why it is so important to get it right.

To achieve these laudable goals, higher education curricula have historically been based on disciplinary thinking, perpetuating the strict borders of specific disciplines and frowning on crossing disciplinary borders. Despite multidisciplinarity and interdisciplinarity innovations, disciplinary departments still remain the most common organisational model for higher education (Drugus, Gherasim, & Cemeciu, 2006). Separate disciplines are unified through well-developed jargon and concepts, techniques and tools, methods and methodologies, journals and library holdings, and professional associations and conferences. Intradisciplinary cadres of scholars find their home in these hard-shelled silos (Ertas, 2000).

Higher education now faces a profound challenge in contemporary times, characterised by an integrated, boundary-less, ever-evolving (some would say degenerating) world. Appreciating that the artificial separation of disciplinary content was doing a disservice to the world, a movement began, focused on drawing on a range of disciplines to face modern-day complexities (Davies, 2009). Viewing curriculum as a construct (something that is built to hold things together), Davies proposed that, instead of viewing disciplines as blocks of knowledge that define what to know and do, people in higher education should see disciplines as opportunities to explore different ways of thinking, through deep inquiry into complex world issues.

Davies (2009) maintained that the boundaries that graduates are expected to cross *outside* of higher education should encourage curriculum planners to look carefully at how learners are socialised about boundary crossing while *in* school. To that end, the previously constructed curriculum would have to change and be rebuilt to contain different things, with the most important outcome being transdisciplinary learning and habits of mind: 'Transdisciplinary learning is the exploration of a relevant issue or problem that integrates the perspectives of multiple disciplines [with other ways of knowing] in order to connect new knowledge and deeper understandings to real life experiences' (Greenwich Public Schools, 2011: 7). The higher education curriculum would study complex issues that are supported by knowledge, concepts and skills from the traditional disciplines, but utilise them in ways that transcend the confines of these disciplines. Nicolescu takes this idea further, challenging higher education to move beyond just disciplines to co-create knowledge with the rest of the world (1993, 1997, 2005). He defines transdisciplinarity as 'that which is at once *between* the disciplines, *across* the different disciplines, and *beyond*

all discipline'. Its goal is '*the understanding of the present world*, of which one of the imperatives is the unity of knowledge' (Nicolescu, 1997: 3). Knowledge from an array of disparate sources has to be united and transformed into something new, which then cannot be reduced back to old knowledge. This is a form of deep knowledge, created by merging fundamental disciplinary knowledge with knowledge from the lived world. Deep knowledge comprises underlying meanings and principles, integrated with previously existing facts and feelings (Rogers et al., 2009).

Because transdisciplinarity is about understanding the world using newly created deep knowledge, higher education especially needs to foster and facilitate deep learning and deep education (Chan et al., 2014). Deep education concerns the whole person, a deep sense of human identity and involves a reconceptualisation of how people view their reality. Deep learning and understandings lead to deep knowledge. Deep education 'promotes a philosophy of curriculum that explains and addresses the current stakes and that requires a deep transformation of humans and human society in the direction of greater harmony' (Tochon, 2010: 5).

Deep learning is actually predicated on the concept of *depth* (versus shallowness). Depth refers to complexity and profundity of thought (penetrating deeply), to incredible intensity and to comprehensiveness of study. The mental acuity and tenacity inherent in deep education means that it is 'never fully achieved, it is always in the making' (Tochon, 2010: 2). Likewise, transdisciplinarity is never done, because the deep problems of humanity change as people engage with them, and the knowledge co-created during transdisciplinary initiatives is always in-formation, alive: what Nicolescu (2005) calls *in vivo knowledge*.

Basarab Nicolescu often speaks of the *transdisciplinary project*, focused on 'the assimilation of an open mentality adapted to the challenges of our present world, a new humanism restoring the dignity of the human being and an ethical code based on rigor, openness and tolerance' (Dincã, 2011: 119). Tochon (2010) explains that higher education students need a global view of *the human project and* that higher education needs to engage in 'the quest for a *deeper* sense of humanity and humanness' (p. 3, emphasis added). This quest will require a transdisciplinary higher education pedagogy that ensures both transdisciplinary learning (via a transdisciplinary learning cycle) and the attainment of transdisciplinary habits of mind (see Fig. 1.2).

1.2 Transdisciplinary Learning

With disciplinary learning, students gain expertise in one discipline, with no commonality among areas of study. Conversely, transdisciplinary learning assumes that *common learning* is far superior to disciplinary rigour (Müller, Tjallingii, & Canters, 2005). In more detail, 'transdisciplinary learning is the exploration of a relevant issue or problem that integrates perspectives of multiple disciplines [and sectors] in order to connect new knowledge and deeper understanding to real life experiences' (Kompar, 2009: 1). It 'provides a perfect opportunity for students to realise that disciplines are constructed [by humans], are continuously changing and can be questioned' (Davies, 2009: 1).

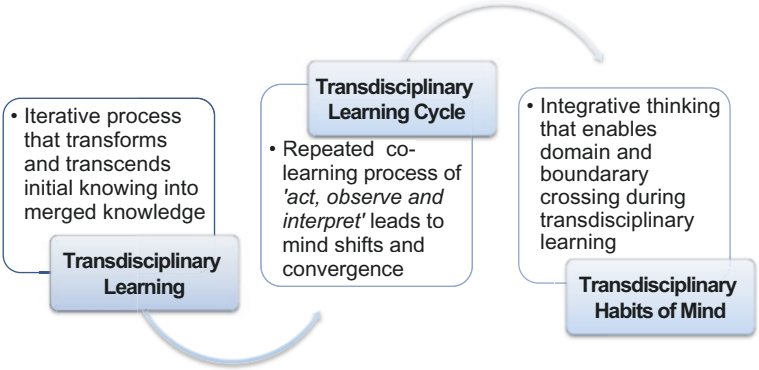

Fig. 1.2 Three dimensions of transdisciplinary learning

Transdisciplinary learning is characterised by four features: (a) it relates to socially relevant issues, (b) it transcends and integrates disciplinary paradigms, (c) it involves participatory research with those affected by and living with the complex social problems, and (d) it entails a deep search for a unity of knowledge (Pohl, 2011). It draws together concepts, theories, and approaches from parent disciplines' and stakeholders' knowledge systems and lived experiences, and then *transforms* these into new TD knowledge, which is possible because boundaries have been broken down or transcended. TD learning is driven by the need for new knowledge creation to address complex problems of humanity (Park & Son, 2010). To that end, higher education learning must involve a multidimensional approach, encompassing disciplinary knowledge as well as lay and local knowledge of those living the problem (Gibbons, 1997).

'Transdisciplinary learning is important' (Stahl, Cimorelli, Mazzarella, & Jenkins, 2011: 497). It helps students to gain better understandings of how their and others' perspectives, knowledge and values contribute to solving problems. In particular, if opportunities are provided for altering the perspectives, knowledge and values that are being examined, iterative learning is possible, leading to appreciations of how each actor's *position* on an issue can change as other's positions are brought to bear. As well, students learn that what they *know* can remain the same, but be viewed differently, as different people's perspectives are brought to bear (Stahl et al., 2011). Students would learn to expect that disciplines' and stakeshar-ers' knowledge systems will come into play as needed or desired throughout the joint problem-solving process.

TD learning requires students to open their minds to an array of competing perspectives on how to solve problems (even on what constitutes a problem). It is all about merging divergent perspectives to problem solve (McGregor & Volckmann, 2011). This inherent crossing back and forth, in and out, and over and under each other's perspectives and positions opens 'newer learning', because this type of learning poses important questions about thinking and gives learners permission to question. Transdisciplinary learning helps students to see problems in even more

than three-dimensional *depth,* because it mimics the complexity of the problems that people experience in the real world (Davies, 2009). People 'creatively move into, through, across [and beyond] disciplines in order to *open meaning* [emphasis added], rather than be pinned down by [disciplinary] facts' (Davies, 2009: 2).

Transdisciplinary learning involves learners sharing their disciplinary-specific skills and experiences (via cross-training), so that they can co-produce new knowledge with other people. Because the traditional boundaries between disciplines and between sectors are intentionally broken down, it is necessary to socialise learners to expect to create new, integrated intellectual frameworks, not just to draw disciplinary concepts together. Co-creating new knowledge requires collaboration. Effective collaboration presupposes, at a minimum, a rough understanding of (or at least respect for) each actor's values. Plus, everyone uses terms that have different meanings in different disciplines, institutions or sectors (Müller et al., 2005). Upon becoming familiar with each other's values, as well as disciplinary and sectoral jargon and concepts (so they can *really* talk to each other and *really* hear what each is saying), learners can combine perspectives to build new transdisciplinary knowledge (Park & Son, 2010).

The work of any group engaged in transdisciplinary learning and problem solving is highly integrated and to some degree organised, informed by comprehensive constructs and methods that transcend (go beyond) disciplinary structures and conventions. Through increased levels of trust, blurring of disciplinary boundaries and escalated valuing of each other's knowledge and perspectives, transdisciplinary learners become a community of learners working for a common cause, rather than just a collection of people (Derry & Fischer, 2005; Wall & Shankar, 2008). Students would be taught that this mode of knowledge creation is socially accountable and reflexive, meaning that people would take into account the effect of different people on what is being investigated (Derry & Fischer, 2005; O'Reilly, 2004). Transdisciplinary knowledge creation is 'a social, negotiated and iterative process', stemming from 'the integration of a diversity of disciplinary [and other sector] perspectives into the problem' (O'Reilly, 2004: 726).

1.3 Transdisciplinary Learning Cycle

A transdisciplinary model for higher education would transcend (i.e. move beyond, to a new space) the artificial boundaries imposed by traditional academic organisational structures by teaching students to view problem posing and solving as an enterprise comprising teams of many people from diverse backgrounds (i.e. disciplines and beyond the academy) (Ertas, 2000). Müller et al. (2005) envision a transdisciplinary learning approach that helps people from different disciplines and sectors to work together to establish a common orientation to the issue at hand. (a) Each participant would articulate their position (including any limitations), and (b) all participants would accept the superiority of a common learning approach over

disciplinary stances stemming from arbitrary, artificial boundaries. Common learning involves all participants engaging in integration and service, leading to the convergence of mindsets yielding new, agreed-to TD knowledge (i.e. created together using the best of what emerged during border work).

A crucial aspect of learning is change. Conventional learning theories assume that, with appropriate education and pedagogy, (a) behaviours can change (behaviourism), (b) mental processes can change (cognitivism), (c) meaning can change (constructivism), (d) the self can change (humanistic), (e) social interactions can change (social and situational learning), and (f) consciences can change (transformative). Most of these learning theories assume that learning occurs inside a person (Siemens, 2005; Smith, 2003). Proponents of transdisciplinary learning assume that learning occurs concurrently within and outside a person, individually and collectively. Müller et al. (2005) embrace this assumption in their model.

Müller et al.'s (2005) approach to transdisciplinary learning involves a three-step learning cycle, with learning occurring through continuous interactions between internal interpretations and external actions. Their model consists of three steps (see Table 1.1): creative, descriptive and normative. First, each participant comes to the table with his or her own purpose, concepts, knowledge and interpretations of the world. Second, informed by their internal perspectives, each participant poses actions, which have a series of expected and unexpected effects. Third, these actions and consequences are observed and described by each participant, leading to a convergence of viewpoints inspiring the creation of new knowledge, ideas and concepts. Each participant's interpretation of these shared data (including boundary judgements), their view of the problem, their chosen approach and possible solutions might shift, which could lead to new ideas and concepts, and the TD learning cycle continues.

Table 1.1 Three-stage transdisciplinary learning cycle

Creative (use imagination and original ideas to bring something into existence)	Descriptive (provide a detailed account of something by writing it down or verbally articulating it)	Normative (internal norms that provide standards for behaviour and making sense of life)
Design cycle	Research cycle	Deliberation cycle
• Action or experiment leading to creation of new forms • Achieved through activities (speak, write, build) yielding objects awaiting description • Translates internal thoughts and feelings into external forms	• Observation of forms created in previous cycle • Achieved through reading, watching, listening, tasting and measuring; results in boundary judgements • Translates what is observed in the external world to the inner world, awaiting interpretation	• Interpretation (give meaning to what is observed) • Internal world of thoughts, meaning, knowledge, concepts, ideas, values and norms • Internal process that translates information from observations to purpose
An object from the *design* phase is used as input for the *research* phase, whose meaning is then *deliberated* by all actors party to the learning process. This process entails individual as well as group learning, such that new TD knowledge emerges from iterative border work		

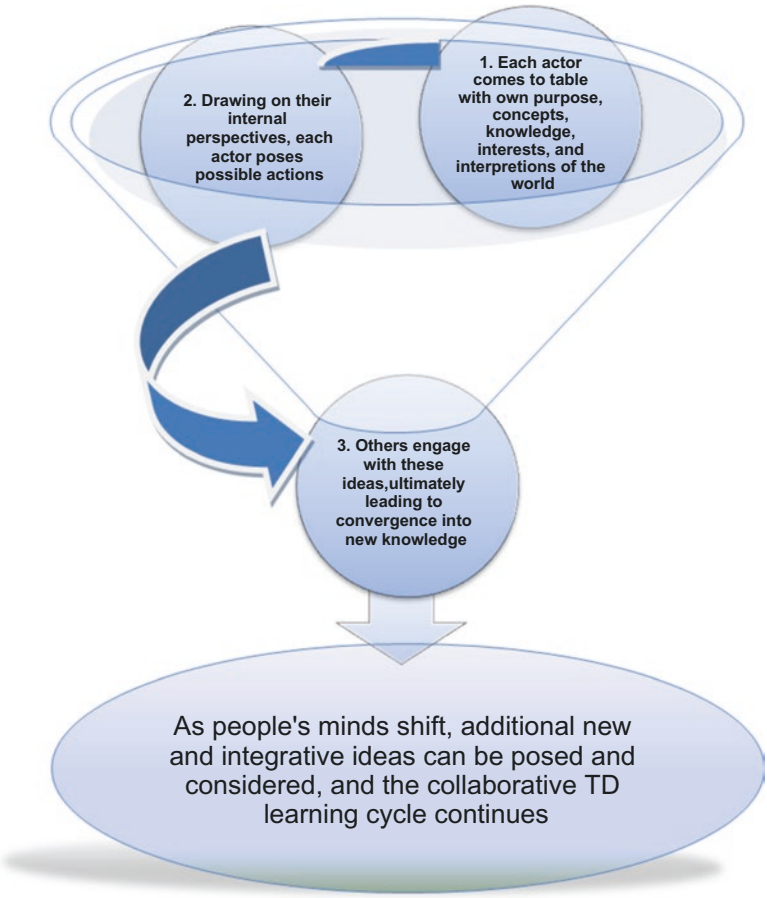

Fig. 1.3 Three-step transdisciplinary learning cycle

Müller et al. (2005) suggest that this TD learning approach can best be represented using a helix to illustrate that the cycle has no beginning nor defined end: one could start with interpreted knowledge, take action based on this knowledge, observe the consequences and interpret the results to get new knowledge, leading to another set of actions, which are observed and interpreted, and so on (see Fig. 1.3). They also describe the learning cycle in this way: 'the creative step [action] is a translation from the internal world of thoughts and feelings to the external world of forms; the descriptive step [observe] is a translation from the external world to the internal world; and the normative step [interpretive] is a translation from information to purpose [leading to the next act] (p. 200).

Müller et al. (2005) likens TD learning to a form of double-loop learning wherein actors actively seek to solve problems by revealing what is not working and trying to fix it. With single-loop learning, they solve problem within existing parameters. Double-loop learning involves critically questioning governing principles, norms

and variables, ultimately altering them and thereby shifting the way that people approach the entire scenario. Rather than take the status quo for granted, transdisciplinary learners would test and challenge basic assumptions and positions brought to the enterprise by all actors (Argyris & Schön, 1978). They iteratively articulate ideas and suggestions, deliberate them and take action, with the cycle repeating itself. As they engage in this process, learning *reoccurs* for all actors, thereby enriching the TD problem-solving process. Müller et al. (2005) refer to this as 'a common learning process, which coordinates and organises the disciplinary learning process [concurrently] with team learning' (p. 201). In effect, their learning model integrates disciplinary theory with real-world practice, in that it involves researchers and scholars from different disciplines, in concert with decision makers and citizens affected by the possible decisions.

Actually, their TD learning cycle respects Schmitt's (2007) call for a transdisciplinary learning approach, wherein people can 'effectively communicate across disciplines and sectors, value other's expertise and knowledge, establish necessary relationships, ask important questions, integrate shared learning and grow in self-confidence while successfully working [and learning] with others' (p. 1). This cross-border work requires transdisciplinary habits of mind.

1.4 Transdisciplinary Habits of Mind

Transdisciplinary thinking helps people to deal with the complex, wicked societal problems that require knowledge across all aspects of society: academic research disciplines, communities, civil society, industry and governments; that is, it involves the integration of knowledge from multiple knowledge systems or knowledge spheres. Thinking from a TD perspective means that people have to: (a) recognise and value the multiple interacting parties, while (b) allowing themselves to self-(re) organise during the perspective-sharing and problem-solving process (Apgar, Argumedo, & Allen, 2009). They need to develop transdisciplinary habits of mind, understood to mean being predisposed to behave intelligently when they do not know the answer to a problem (created by dichotomies, dilemmas, enigmas and uncertainties). They help people to face circumstances that demand perseverance, tolerance, creativity, reasoning, insightfulness and craftsmanship (Costa & Kallick, 2008). Transdisciplinary habits of mind prepare learners and graduates for these contingencies (Derry & Fischer, 2005; Mishra & Koehler, 2006; Mishra, Koehler, & Henriksen, 2011).

Mishra et al. (2011) identify seven habits of a *transdisciplinary mind*, cognitive skills that every individual tends to use when creatively thinking *across a range of domains* (appreciating that acquiring and applying this cognitive skill set is not easy). These TD mind skills are universal and employed by people who are inclined to integrate different solutions, viewpoints and perspectives. They include: perceiving, patterning, abstracting, embodied thinking, modelling, play and synthesising (see also Mishra & Koehler (2006) and http://tpack.org) (see Fig. 1.4).

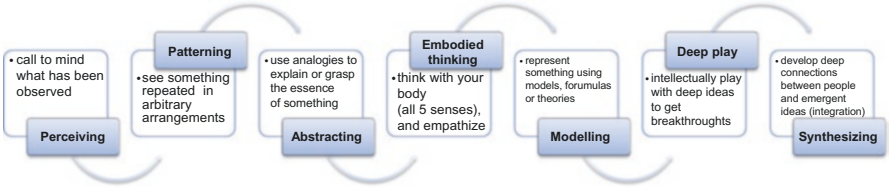

Fig. 1.4 Seven transdisciplinary habits of mind

First, *perceiving* is a two-layered process. People learn to observe using their five senses, and then they learn the process of *imaging* (calling to mind what they observed without any external stimuli). Second, *recognising patterns* involves identifying a repeating, discernible form or plan in a seemingly arbitrary arrangement. Third, *abstracting* entails two processes. To begin, people extract and focus on one feature of a thing to grasp its essence. Then, they use analogies (comparisons between two seemingly disparate things) to explain the abstraction (Mishra et al., 2011).

Fourth, *embodied thinking* is also two-pronged, kinaesthetic and empathetic, wherein learning is transformed from static to tactile. Thinking is heavily influenced by body movements and sensations. Kinaesthetic thinking involves people 'thinking with their body', learning how to use the five senses to know the world around them. Thinking with the body also involves putting oneself in another person's position in order to understand them (i.e. out of one's body into another body's experience, so one can empathise) (Mishra et al., 2011).

Fifth, *modelling* involves both abstractions and analogies, noted earlier, and *dimensional thinking* (space and time). When people model (or think dimensionally), they build replicas or use theories or formulas to represent and then study something to discern its purpose, nature or composition. *Deep play*, the sixth universal TD mind habit, involves people intellectually playing with ideas, concepts, boundaries or processes, so that they can open doors to new ways of thinking via unexpected breakthroughs. Beyond everyday superficial play, deep play is characterised as open-ended, and often leads to transformations (Mishra et al., 2011).

Deep mental manipulation of ideas helps people to make unexpected conceptual links as a result of integrating and synthesising disparate ideas. Indeed, the final TD mind habit of *synthesising* involves feeling and thinking coming together into many and new ways of knowing, which could not have emerged if everything had remained separate and disconnected. Through synthesis, people develop deep, empathetic, complex connections between *each other* and their attendant *ideas and positions* (Mishra et al., 2011), the hallmark of transdisciplinary thinking.

Derry and Fischer (2005) also discuss transdisciplinary competencies and mindsets, arguing that learners need these as well as disciplinary-specific, in-depth knowledge (see Lattanzi, 1998). They propose three mindsets (habits of the mind) that bring disparate disciplines and actors together: knowledge about boundary objects, communities and metacognitive skills that foster reflective community.

First, knowledge exchange requires hosts coming together and crossing boundaries (e.g. researchers, journals, bureaucracies, standards, stakeholders/stakesharers). These hosts collectively bring and/or create *boundary objects* or artefacts that cluster at the edges of borders, with the potential to connect ideas across people. Examples are ideas, standards, products or designs. These objects can impede and expedite transdisciplinary learning. Ideally, these artefacts will help to make ideas comprehensible to people from other disciplines and sectors.

Second, transdisciplinary learners need to have a commitment to the collective creation, expansion and building of knowledge through knowledge creation communities. A community is a group of people living in one space. In this case, it is a temporary collection of people deeply concerned with the resolution of a complex human problem. They need to be able to find common ground so that they can work together to create shared knowledge. Through mutual learning and collaborative problem solving, these knowledge creation communities create new TD knowledge. As transdisciplinary learning communities, they are heterogeneous and involve many different actors, unlike communities of practice, which tend to be monodisciplinary (Derry & Fischer, 2005).

Third, TD learners must be able to think about and monitor their thinking (i.e. use their metacognition skills to 'think about their thinking'). This habit of the mind supports a *reflective* transdisciplinary knowledge creation community. People must be skilled at reflecting on data, concepts and real-world items; the activities of the problem-solving system/community; and their modes of participation and inquiry. They would reflect during TD border work and afterwards, respectively called reflect-*in*-action and reflect-*on*-action (Derry & Fischer, 2005) (see Schön, 1983). Reflection on their transdisciplinary work may be affected by distances that emerge within the community. People may be distanced geographically, conceptually, ideologically, technologically and socially (meaning that inequities that emerge during TD border work are impacted by gender, discipline, minority or group membership). Learners would respect that reflections during and after TD community work should take into account these distance elements that can deeply shape relationships and interactions (Derry & Fischer, 2005).

1.5 Discussion and Conclusion

This chapter made the case that higher education must continue to move from disciplinary-based learning to transdisciplinary learning, which entails educators using the transdisciplinary learning cycle and helping students to gain TD habits of mind. TD learning is relevant to the real world; it is authentic. Rather than confining learning to disciplines, TD learning uses the disciplines and knowledge from civil society to support and enrich learning about universal understandings common to all of humanity. Rather than compartmentalising learning to specific disciplines, TD learning uses an inquiry-based pedagogy. Students learn to investigate a problem or complex issue collaboratively through different questions and perspectives. They

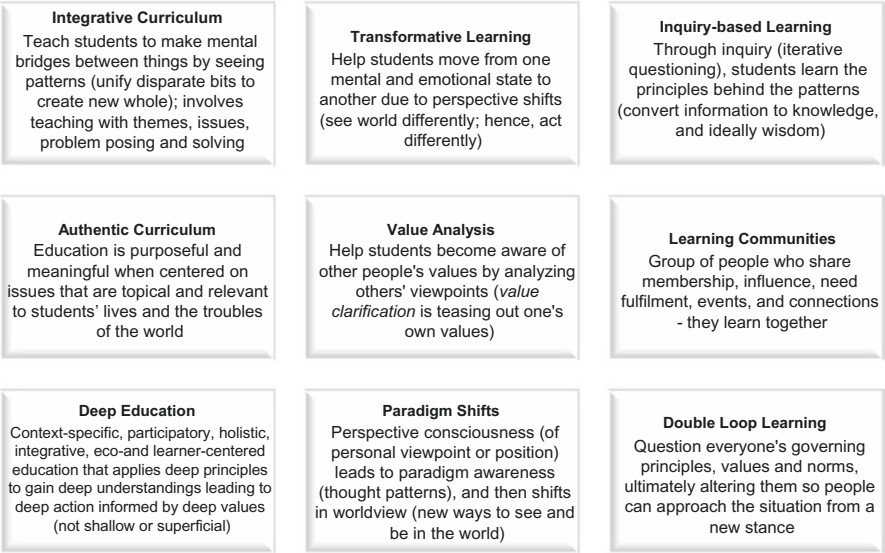

Fig. 1.5 Nine possible transdisciplinary higher education pedagogies

end up with deep, layered understandings of themselves and the connections that they have with the rest of humanity ('How is thematic learning', ca. 2008; International Baccalaureate Organization, 2010; Kompar, 2009).

Most importantly, transdisciplinary work:

> brings together academic experts, field practitioners, community members, research scientists, political leaders, and business owners among others, to solve some of the pressing problems facing the world, from local to global…. [This leads to] a globally inclusive community [diverse] in terms of geography, nationality, as well as scientific and cultural perspectives. (Aguirre, 2008: 238)

Thompson Klein (1994) refers to these as *hybrid communities* that enable collaboration and integrative problem solving 'at the boundaries and in the spaces between systems and subsystems' (p. 1). Any higher education curriculum prepared from a transdisciplinary perspective would teach students how to function and thrive in these hybrid communities, once they graduate. Upon reflection, higher education curriculum planners and instructors can benefit from gaining richer understandings of what learning looks like through a transdisciplinary lens and how their pedagogical approach can change to ensure that TD learning thrives (see Fig. 1.5, which shares nine pedagogical orientations emergent from this particular discussion of transdisciplinary learning).

In conclusion, through the process of overarching synthesis and critique, transdisciplinary higher education would teach students to transcend (go beyond the limits of) the fragmented scope of disciplinary cores leading to the active co-construction of knowledge, ideas and procedures with others; that is, the curriculum would mobilise the process of extending beyond something (Palaiologou, 2010). By

respecting this transcendence, higher education can socialise students to witness the emergence of new data, patterns, relationships and interactions from their encounters with different actors. Students would learn to (yearn to) move beyond confining disciplinary silos, because transdisciplinary learning teaches everyone to strive to be open to that which they share and that which lies beyond them, yet to be discovered, together (de Freitas, Morin, & Nicolescu, 1994).

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Chapter 2
Seeing What Is Questionable: Transformative Pedagogies and the Hermeneutic Subject

Jon Nixon

The real power of hermeneutical consciousness is our ability to see what is questionable.

Gadamer (1977: 13)

2.1 Introduction

Almost all the problems we now face are collective problems. These are problems that, as Paul Gibbs (2015: 152) puts it, 'tend towards the complex and heterogeneous' and that – although global in scope – are experienced as 'specific, local and uncertain'. As such, they can only be fully addressed through translateral discussions drawing on diverse perspectives and paradigms. Globalisation, in other words, presents us not only with economic, political and social challenges, but with a huge hermeneutical challenge: a challenge, that is, to our understanding. How, in a world of seemingly incommensurable difference, are we to engage in conversations that are both constitutive of, and conditional upon, shared understanding?

That was the kind of question that the German philosopher Hans-Georg Gadamer sought to address. Gadamer's life spanned the long twentieth century. Born in 1900, he lived till 2004, thereby surviving World War I, the rise of Nazism, World War II and the Cold War. At a highly formative stage in his intellectual development, he fell under the influence of Heidegger (Grondin, 2003: 91–108). Thus began what Robert J. Dostal (2002: 16) describes as 'a relationship that was difficult, complicated, and decisive from the very beginning'. Heidegger, having relied on Gadamer to ease his transition into an extraordinary professorship in philosophy at the University of

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Marburg, refused to supervise his *habilitation* (a major post-doctoral study required to qualify for an academic position). Badly shaken, Gadamer then switched to classical philology with a view to gaining the necessary state qualifications to become a teacher of classics.

Gadamer successfully completed the necessary course of study and duly qualified, at which point – and 3 years after his initial refusal to support Gadamer – Heidegger agreed to supervise his *habilitation* thesis on *Plato's Dialectical Ethics*. (See Gadamer, 1991.) Although experienced by Gadamer as a severe setback, his academic detour had the unforeseen consequence – unforeseen, that is, by either Gadamer or Heidegger – of enabling him to make some vital connections between classical philology and philosophical hermeneutics. In so doing, it helped to pave the way for his 1960 magnum opus, *Truth and Method*, which established hermeneutics as a major philosophical field.

Hermeneutics is primarily concerned with the question of how we understand the human world and its relation to the natural world. Its primary response to that question is that understanding necessarily involves an element of interpretation. Understanding, in other words, is not about passive reception and revelation, but about how we actively interpret what we have received and are receiving, and what has been and is being revealed. Starting from this premise, hermeneutics developed throughout the nineteenth century as an important branch of interpretive methodology, whereby the principles of textual exegesis were established and applied in the interpretation of, in particular, religious texts within the Judeo-Christian canon, but also more generally within the Western and European humanistic canon.

Philosophical hermeneutics was shaped by this largely Eurocentric outlook, but was premised on a further and more universal assumption; namely, that interpretation is part of the human condition. We are born into a world that requires us to make sense of it. That is what defines our common humanity. There is, then, a clear link between hermeneutics as a philosophical field of enquiry devoted to the interpretation of the human world and ontology as the field of philosophical enquiry devoted to the nature of being and becoming. For Gadamer, this link was an all-important means of revitalising the hermeneutic tradition and establishing its ethical bases: it is by making sense of the world – and of ourselves in the world – that we realise our full human potential as ethical agents. That tradition – experienced as continual reacquisition and reinterpretation – provided the intellectual context within which Gadamer pursued his philosophical quest. It was a tradition that preserved what he held to be true, while acknowledging that part of what we hold to be true is that '[p]reserving is not an unquestioning clinging to what is'. 'In the end,' as he put it, 'we have to learn from Plato that we must continually renew what we hold to be true' (Gadamer, 1992: 91).

This chapter focuses specifically on the work of Gadamer in order to highlight some key issues and questions relating to teaching and learning in higher education. Following a brief account of the hermeneutical tradition within which Gadamer's work is located, I discuss his unique contribution to that tradition: his insistence on the central importance of the hermeneutic subject and on the primacy of the question. Finally, I pose just some of the many questions that, as teachers, we might ask

ourselves in the light of Gadamer's insights into the nature of human understanding. Throughout I write as a teacher addressing fellow teachers and on the assumption that teaching can never be reduced to a set of generic competencies and skills, but always involves a unique – and uniquely purposeful – encounter between particular individuals each with her or his particular history, dispositional outlook and expectations for the future.

2.2 From Vico to Gadamer

In mid-eighteenth-century Milan – two millennia after Plato established what Gadamer took to be the dialectical bases of hermeneutics – an obscure professor of rhetoric named Giambattista Vico claimed to have uncovered 'the order of all progress from its first origins'. He elaborated this 'order of progress' in terms of what he termed 'the course of nations' central to which was 'the recurrence of human institutions': 'at first there were forests, then cultivated fields and huts, next small houses and villages, thence cities, and at last academies and philosophers' (Vico, 2001: 15). Implicit in his argument is that these human institutions are historically situated, but that they constitute a category that is sustainable across history. Writing both within and against the Enlightenment that had illuminated the scientific potential of the natural world, Vico was exercised by the idea that the divinely ordained natural world can only be understood in the light of the human world that had evolved and was still evolving in time.

That world, he sought to show, could only be understood chronologically. History was, as Vico saw it, the key to worldly understanding. He set out to establish an understanding of the evolution of human societies that was as revolutionary in its time as Darwin's application of the notion of 'evolution' to the life sciences over a hundred years later. He lay the foundations of what we now categorise as 'the humanities' and of what is now practised as 'anthropology', 'cultural studies', 'history', 'sociology', and so on, but he never lost sight of the partiality of human understanding. 'There is always', as the literary and cultural critic Edward Said (2004: 12) put it, 'something radically incomplete, insufficient, provisional, disputable, and arguable about humanistic knowledge that Vico never loses sight of'.

However, the impact of Vico's *New Science* extends beyond 'the humanities'. The third edition of this work published in the year of his death – and 'thoroughly corrected revised, and expanded by the author' – shows how all human knowledge is historically located and therefore open to interpretation. The 'rules' of science, as developed by contemporaries such as Newton, were not, Vico implied, absolute and for all time. They were necessarily relative to their age and, as such, open to question. They were *interpretable*. Vico routed the tradition of hermeneutic enquiry into the modern age of scientific enquiry. He was virtually unrecognised in his day and his work had little influence, but his long-term impact is indisputable. The world is not entirely given, but made through our own understanding of it; and, as Marx went on to argue, if the world is what we make of it, then we can struggle to make of it a

better world. Vico's great, sprawling and (by our contemporary standards) unscholarly work is the hinge upon which the hermeneutic tradition turns towards historical consciousness.

Two insights in particular form the basis of that tradition. The first insight is that *in any attempt at interpretation, we are interpreting that which has already been interpreted*. The object of our interpretation is a construct that we inherit from the historical layering of countless prior interpretations and re-interpretations. There is no blank page of history upon which we can inscribe our entirely original understandings. History is a palimpsest of layered inscriptions and layered commentaries. The second insight follows from the first. If all understanding is always already interpretation, then *the interpreter is part of what is being interpreted*. The subject that interprets is implicit in the object of interpretation. Notions of 'objectivity' and 'neutrality' as the privileged criteria of rationality become increasingly difficult to justify in the light of this second insight.

These two insights were implicit – rather than explicit – in *New Science*. Vico was feeling his way towards a new world view that was still embryonic. He was fascinated by prehistory and how, prior to a chronological and sequential notion of time, people nevertheless located themselves historically. He understood that the past was another country that had to be understood on its own terms, rather than on our terms. His formulation of the 'epochs of world history' into 'the ages of gods, heroes, and men' may seem strange and esoteric to us, but in its time it was path-breaking in its insistence on past epochs as interpretive constructs expressed in terms of mythology, political constitutions and legal frameworks. History is what we make of it, and what we make of it is inextricable from how we understand it. These were ideas that would inspire and inform the work of, among others, Karl Marx and James Joyce. At the time, however, Vico was still finding a language and form within which to express and elaborate them.

A third insight follows from the first two and was developed in particular by Gadamer. If all understanding is always already interpretation and the interpreter always already part of what is being interpreted, then *all understanding necessarily involves an element of self-understanding*. Gadamer elaborates this insight with reference to the notion of 'application', which he understood as being implicit in all understanding from the moment of its inception. It is not that understanding is achieved and then applied, but that application is intrinsic to the process of understanding: 'in all understanding an application occurs, such that the person who is understanding is himself or herself *right there* in the understood meaning. He or she *belongs to* the subject matter that he or she is understanding… Everyone who understands something understands himself or herself in it' (original emphases, Gadamer, 2001: 47–48). The hermeneutical task, as Gadamer defines it, is to locate ourselves within our own field of understanding.

2.3 The Return of the Subject

What the interpreter brings to the process of interpretation is, then, of vital importance. We understand the world in relation to what we bring to it by way of prior assumptions, preconceptions and prejudices. This perspective, as Gadamer (2004: 271) puts it, 'involves neither "neutrality" with respect to content nor the extinction of one's self, but the foregrounding and appropriation of one's own fore-meanings and prejudices'. What he terms 'the fundamental epistemological question' then becomes: 'what is the ground of the legitimacy of prejudices? What distinguishes legitimate prejudices from the countless others which it is the undeniable task of critical reason to overcome?' (p. 278). Prejudice – what we bring with us into the event of understanding – is where interpretation begins: 'the concept of 'prejudice' is where we can start' (p. 273). We bring to the task of interpretation values and assumptions that are uniquely shaped by our origins and that are having to be constantly sifted and transformed. The literary scholar Stephen Greenblatt (2013: 5) makes this point tellingly when he writes: 'I am incapable of simply bracketing my own origins; rather, I find myself trying to transform them, most often silently and implicitly, into the love that I bring to my work.'

Gadamer insists that this importing of ourselves into the process of understanding is a necessary component of that understanding. However, he also insists that we must be aware of what we are importing. Some of our prejudices may assist understanding, while others may distort or deny understanding. A large part of the hermeneutical task involves self-examination through the sifting of prejudices. To have trust in an interpretation is to trust that the interpreter has undergone this process of self-examination in respect of the values and assumptions that have shaped that interpretation. Similarly, to trust in one's own interpretive capacity is not to have blind faith in one's own convictions, but to trust in one's own commitment to questioning those convictions. Trust is a necessary condition of understanding and understanding is a necessary condition of our being in the world: 'Social life depends on our acceptance of everyday speech as trustworthy. We cannot order a taxi without this trust. Thus understanding is the average case, not misunderstanding' (Gadamer, 1992: 71). If we trusted nothing in this world of ours, then it would be a world beyond our understanding – and a world beyond our understanding is no longer *our* world.

That is why Gadamer (1977: 8) argues that hermeneutics cannot be 'restricted to a technique for avoiding misinterpretation': misinterpretation through the application of inappropriate prejudices is to be avoided, but that avoidance does not in itself constitute understanding. I gain understanding not only by rejecting inappropriate prejudices, but by using other of my prejudices to connect with what I am seeking to understand. In explicit opposition to the scientific ideal of objectivity devoid of all prejudice, Gadamer insists on the productive power of prejudice. He rejects as alienating the mistrust of the subject – and of 'subjectivity' – that he sees as implicit in that ideal. He argues, instead, for the necessity of trusting to the subject – and to 'subjectivity' – in all understanding. Gadamer is, in effect, inviting us and

encouraging us to acknowledge ourselves in that which we seek to understand. He refuses to accept that we need to bracket ourselves out of the process of understanding in order to achieve 'objectivity'. We are, he maintains, positioned *within* the field of our own understanding and need to acknowledge our own 'positionality' rather than deny it. We cannot occupy some neutral ground beyond or above the epistemological fray. There is no Archimedean point from which to gain some kind of ultimate cognitive leverage. Understanding begins in the middle and muddle of things – *in medias res*.

But, Gadamer insists, he is not arguing on behalf of relativism: an ethics of 'anything goes'. Of course, relativism takes many forms, but in every version the claim is that there is no one absolute truth beyond the culturally and historically embedded truth. Truth, in other words is a relative term. Gadamer rejected what he saw as the false dichotomy implicit in this binary opposition between absolute and relative truth. Rather, he takes as his model 'truth as it emerges in the experience of art', central to which are notions of '*Bildung'* (cultural formation), 'sensus communis' (common sense), 'judgement' and 'taste' (Gadamer, 2004: 1–37). These notions are an attempt to conceptualise what Gadamer sees as key elements within our cultural and historical legacy. They are manifestations of what he terms our 'historically effected consciousness' (Gadamer, 2004: 335–382). For Gadamer, this historical layering of human consciousness – the way in which we are historically constituted – is what we bring to the task of understanding, not as means to an end but as a constituent element of the truth that we seek through understanding.

The grounds upon which Gadamer rejected the charge of relativism flew in the face of contemporary orthodoxy. At the time that he was writing, 'method' was in the ascendancy. The idea of 'method' was particularly associated with scientific enquiry, but the idea of there being a pre-ordained methodology of enquiry across disciplines and fields of study held sway. For enquiry to be taken seriously, whether within the natural, human, or social sciences, it had to be conducted systematically and in accordance with pre-specified methodological procedures. In its most extreme form, this scientific positivism – buttressed by the philosophical presuppositions of logical positivism or logical empiricism as it is sometimes termed – claimed that observational evidence is indispensable for knowledge of the world and that, only when supported by such evidence, could a belief that such and such is the case actually be the case (i.e. be 'true'). A methodical approach to the selection, gathering and analysis of empirical 'data' – and to the inferential process whereby 'findings' were derived from this approach – was and to a large extent still is the means by which scientific enquiry gained legitimacy and public recognition. 'Method' would enable one to gather and analyse 'data' which would then provide knowledge in the form of 'findings'. This became the dominant paradigm of scientific enquiry and exerted a strong influence on the social sciences generally, and on social psychology in particular, where it was supported by the presuppositions of behaviourism.

Gadamer's starting point in *Truth and Method* is the 'problem of method', as he terms it. (Gadamer, 2004: 3–8). Understanding, he maintains, cannot be reduced to a single, rule-bound method, although interpretive methods may contribute to our

understanding. Gadamer does not deny that there are methods, but denies that such methods are constitutive of human understanding or that they constitute a latter-day 'ladder of perfection' leading to the truth: 'As tools, methods are always good to have. But one must understand where these can be fruitfully used. Methodical sterility is a generally known phenomenon'. 'Applying the method', he continues, 'is what the person does who never finds out anything new, who never brings to light an interpretation that has revelatory power.' It is, he concludes, 'not their mastery of methods but their hermeneutical imagination that distinguishes truly productive researchers. And what is hermeneutical imagination? It is a sense of the questionableness of something and what this requires of us' (Gadamer, 2001: 41–42).

Implicit in Gadamer's critique of method is the idea that understanding involves self-formation and human flourishing that is open-ended in the extent and scope of its proliferation. The application of method, on the other hand, assumes a notion of rationality that seeks closure and predictability. Human understanding, argues Gadamer, must be true to the nature of humanity: a humanity that is necessarily fragile and vulnerable by virtue of its complex interconnectivities and its uncertain relation to the future. Gadamer saw this as a struggle between the human and natural sciences, with the latter imposing an inappropriate methodology on the latter: when inappropriately applied to the human world, the scientific method insists upon an ideologically skewed version of humanity. Moreover, since the natural world is always already an interpreted world, the methodology derived from the natural sciences may be severely limited, even when applied within its own traditional domain. For Gadamer, it is not their methodological rigour, but their commitment to 'the questionableness of something' that distinguishes the genuine seeker after truth.

2.4 The Questioning Subject

'Understanding', argues Gadamer (2004: 298), 'begins… when something addresses us'. But that 'something' can only address us when we confront it with the particular question that we wish to ask of it. Who gets to ask the questions is, therefore, a crucial issue for Gadamer, who insists that it is the impulse to question that makes understanding possible. To question is to take a leap into the dark – a leap of the imagination – within which we discover ourselves through the process of inquiry. So, while Gadamer's emphasis on questioning has affinities with what is referred to as 'the Socratic method', it differs markedly in respect of his insistence on the student as questioner. The pedagogical process whereby the teacher is the lead questioner only makes sense from Gadamer's perspective if the purpose of the teacher's questioning is to encourage the student to become her or his own questioner. Teachers may model what it is to be a questioner. They may even prod us into shaping and sharpening our questions. But they cannot ask the questions on our behalf. 'The student', as Graeme Nicholson (2011: 71) argues, 'is invited to think because the teacher does not merely think but fosters thinking through *acting out* thinking in the course of a class' (original emphasis).

What we are and what we become is determined by the questions that we ask of ourselves and of each other. There is, then, in Gadamer's emphasis on 'the hermeneutic primacy of the question', a strong pull towards the ontological – towards, that is, a philosophical preoccupation with the nature of being and becoming. (See Gadamer, 2004: 356–371.) Our capacity to question makes of us what we are and what we become. Crucially, questions open up new possibilities. 'The essence of the *question*', as Gadamer (original emphasis, 2004: 298) puts it, 'is to open up possibilities and keep them open.' Questions extend our horizons. 'Open' questions, in particular – questions, that is, which unlike 'closed' questions do not presuppose a 'yes' or 'no' response – invite us to speculate regarding the options open to us, the choices available to us and the different courses of action that may ensue. Such questions confront us with the unpredictability of the future, while encouraging us to assume responsibility for shaping that future. The ontology of the question as conceived by Gadamer has huge educational implications, since it is only through the formulation of the questions that are applicable to our own conditions and concerns that we acknowledge ourselves within the horizon of our understanding. It is only by asking questions that we grow in understanding and thereby extend that horizon.

The idea of 'horizon' – as developed by Gadamer – relates directly to the importance he places on tradition as the legacy of the past to the future and the corresponding debt owed by the present to the past. In *Truth and Method*, he provides a general explanation of how and why he is using the concept: 'The concept of "horizon" suggests itself because it expresses the superior breadth of vision that the person who is trying to understand must have. To acquire a horizon means that one learns to look beyond what is close at hand – not in order to look away from it but to see it better, within a larger whole and in true proportion' (Gadamer, 2004: 304). The concept as applied by Gadamer invariably relates to our understanding of the past and of how we interpret the past with reference to the sources available to us. Gadamer's central point on this matter is that our horizons of understanding are never static: 'Every historian and philologist must reckon with the fundamental non-definitiveness of the horizon in which his understanding moves. Historical tradition can be understood only as something always in the process of being defined by the course of events' (Gadamer, 2004: 366). In that sense, understanding is always understanding-not-yet-finished.

Questions not only open up horizons of possibility, but provide us with our unique trajectories: our sense of purpose, which is, of course, integral to our sense of self. They direct us towards specific lines of inquiry and particular courses of action. They shift the dimension of inquiry from the horizontal plane of infinite possibility to the vertical plane of focused inquiry. Our questions determine what we attend to, and what we attend to informs who we are what we become. Questioning also draws us into the communicative world of addressor and addressee. Questions presuppose a respondent, which may be the self in internal dialogue or a wider community of shared interest and concern. The crucial point is that, through the formulation of questions, we engage in an ongoing process of communicative engagement, which – to return to Gadamer's refutation of the charge of relativism – constitutes 'a

discipline of questioning and inquiring, a discipline that guarantees the truth' (Gadamer, 2004: 484).

Above all, questions are our human response to whatever is incomprehensible in the world around us. 'Hermeneutics', argues Gadamer (1977: 98), 'operates whenever what is said is not immediately intelligible.' Questions, then, are both an acknowledgement of our limitations in respect of understanding and an expression of our urge to overcome those limitations. They define us as creatures who dwell in the uncertainty and anxiety of partial understanding, while craving a fuller understanding of the partially understood world that we inhabit. It is only by questioning the world around us that we can begin to understand it; and it is only by understanding that world that we can begin to feel at home within it.

The ontological aspect of Gadamer's hermeneutics owes much to Heidegger. But, following Heidegger's public endorsement of Nazism, Gadamer increasingly distanced himself from his early mentor. As Heidegger became progressively drawn towards 'pure' ontology, Gadamer continued to insist on the hermeneutical grounding of ontology in the specificity of the text through the process of reading and re-reading, interpreting and re-interpreting. He was concerned with how we interpret our shared world; how our diverse interpretations inform our daily lives, our day-to-day judgements and our routine decisions; how they render our world meaningful. Above all, he insisted that understanding is ordinary – that it is intrinsic to who we are and what we aspire to be: '[w]e are always already completely encompassed by our expectations and hopes, our prejudices and our fears' (Gadamer, 1992: 231).

2.5 Transformative Pedagogies

The unfamiliar becomes familiar through the engagement of the one with the other, so that both the familiar and the unfamiliar undergo a transformation. This transformation of what is to be understood – and of what lies within the horizon of the already understood – is the event of understanding: the fusion of shifting and extending horizons. The prime pedagogical task, therefore, is to facilitate this transformative event. What we take from Gadamer – and the hermeneutical tradition within which he was operating – is that any such transformation involves an acknowledgement of the open-ended nature of human understanding and its irreducibility to what – as noted earlier – he termed 'methodical sterility'. 'Open-mindedness', suggests Paul Fairfield (2011: 80), 'may well be the most essential condition of educational success in general; without it the mind is unteachable apart from the straightforward acquisition of information that merely confirms what one knows'.

This orientation aligns well with that proposed by the proponents of transdisciplinarity. Kate Maguire (2015: 170) provides a helpful and admirably succinct definition of transdisciplinarity when she writes that it seeks 'to transcend boundaries of disciplines and practices to create a new knowledge synthesis within the individual or domain of practice and indeed in society'. Gadamer is indeed proposing

such a synthesis: a synthesis that focuses neither on disciplinarity nor on methodological rigour, but on the human subject tasked with – and ontologically defined by – an unconditional responsibility for understanding our shared world. There is potentially much common ground between transdisciplinary ways of working and hermeneutical insights into the nature of understanding.

However, one slight reservation should be added: although transdisciplinarity does not speak with a unitary voice, it does – across its now extensive literature – have a focus, albeit subsidiary, on the possibility of developing an overarching and all-inclusive methodology. This possibility is implicit in the question posed by Christian Pohl and Gertrude Hirsch Hadorn (2008: 112) regarding the methodological challenges facing transdisciplinary research: 'will the answer be that a new specialisation in science is underway around the three pillars of systems thinking and complexity science, participatory methods and knowledge management, and that the scholar should better study these theories and methods?' A positive answer to that question regarding the emergence of a new transdisciplinary specialisation would be antithetical to the hermeneutical stance adopted by Gadamer and, no doubt, to many of those working within the field of transdisciplinary studies.

Where hermeneutics and transdisciplinarity find common ground is in their assumption that education fulfils its transformative potential by acknowledging the need to hold open what Gadamer (1992: 45) calls 'this free space of that rationality where ingenious improvisation and innovation occur', and what Maguire (2015: 171) – writing from a transdisciplinary perspective – refers to as 'the domain of epistemic plurality and border crossing'. Both formulations denote an 'in between' terrain, in which shared understanding becomes a possibility and in which our collective responsibility for our bigger-than-self-problems can be activated. It is on this rough ground that the encounter between the teacher and the learner takes place.

Gadamer reminds us that – in that encounter – the teacher is always a learner and that the learner also has important lessons to impart. There are no rule books, no hierarchies of competencies, no pre-specified 'skills sets', but there are a few insights – and the inevitable questions – that Gadamer bequeaths us. Such questions point towards a pedagogy that is both innovative and grounded in a notion of understanding as shared endeavour: a way of meeting across disciplines, and across cultural and religious divides.

2.5.1 The Primacy of the Question…

If, to understand something, as Gadamer suggests, is to articulate the questions it asks of us, then we require pedagogies that recognise students as questioning agents: pedagogies that enable students to grasp for themselves the unique 'questionableness of something'. We then need to ask whether even our more progressive pedagogies measure up to the task: Who asks the questions? Whose questions matter? Are 'open' questions valued as highly as 'closed' questions? How, through our own questioning, can we encourage students to become their own questioners? When – if

at all – do we acknowledge our students' ability to ask questions, rather than answer them?

2.5.2 The Centrality of Dialogue …

If, as Gadamer again suggests, understanding is a conversational process – not just metaphorically, but in practice – then we require pedagogies that encourage and acknowledge reciprocity and mutuality, listening and recognition, and the willingness to maintain openness rather than closure. We need pedagogies that enable students to think together in dialogue. That, then, poses further questions: To what extent do we encourage students to think together and to share their insights and understandings? How do we recognise and acknowledge this dialogical element within our assessment procedures? When – if at all – do we model ways of thinking together in our own teaching?

2.5.3 The Principle of Provisionality…

If, following Gadamer's lead, we see understanding as framed by ever-shifting and ever-stretching horizons, then we require pedagogies that acknowledge both the provisionality and boundlessness of human understanding: pedagogies for understanding-not-yet-finished. Questions that go to the heart of what we mean by 'lifelong learning' then follow: How do we enable students to acknowledge the provisionality – and uncertainty – of human understanding while also discovering purposeful trajectories and imaginaries? What dispositions and qualities are required of them and of us? When – if at all – do we address the ontological insecurities that are inherent in the very notion of 'understanding-not-yet-finished'?

2.5.4 The Indeterminacy of Outcome…

Finally, if understanding cannot be reduced to method, but always involves an element of what Gadamer calls 'hermeneutical imagination', then we require pedagogies that acknowledge intuition and inference, celebrate the surprising and the unexpected, and encourage speculation and the taking of risks. We need pedagogies that operate outside the managerial frame of pre-specified outcomes and identifiable targets. Among the questions that then arise are: Would we recognise a significant but unexpected learning outcome if it occurred? Do such outcomes figure in our assessment routines and audit procedures? When – if at all – do we value and acknowledge the surprising and unexpected when it occurs within our tutorials, seminar rooms and lecture halls?

2.6 Conclusion

'In a future Gadamerian culture,' argues the philosopher Richard Rorty (2000: 25), 'human beings would wish only to live up to one another, in the sense in which Galileo lived up to Aristotle, Blake to Milton.… The relationship between predecessor and successor would be conceived… not as the power-laden relation of "overcoming" (*Überwindung*) but as the gentler relation of turning to new "purposes"' (*Verwindung*). The event of understanding is located at the turning point between past and future: the still turning point of the present. It gathers the past – our own past and the past of myriad others – in order to address the huge and seemingly insurmountable problems we face in the present and to feel our way forward into the future.

Gadamer teaches us to respect the past, but not to be held in thrall by it. He teaches us to engage with the strange and unfamiliar, rather than be fearful of it. 'The real power of hermeneutical consciousness', as he claims in the quotation that heads this chapter, 'is our ability to see what is questionable.' Above all, he teaches us that all understanding is always dialogical, and that we can and must reason together if we are to survive and flourish as intelligent and sentient beings. We might then begin, as Rorty puts is, 'to live up to one another' – to live up, that is, to the very best in one another and, in so doing, discover new purposes, new ways forward. Gentle though his admonitions may have been, Gadamer's central message is prophetic: we must understand one another or face the loss of that which defines our humanity.

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Chapter 3
Interdisciplinarity, Transdisciplinarity and the Higher Education Curriculum

David Scott

3.1 Introduction

The first part of this chapter focuses on the higher education curriculum, with the understanding that this is informally structured and consequently localised in the United Kingdom, and the second part is an examination of two key epistemic notions, interdisciplinarity and transdisciplinarity, in relation to the generic development of a curriculum. A curriculum, in essence, is a planned programme of learning. As a concept, learning is fundamentally related to knowledge. Indeed, it would be difficult to think about learning and the practices of learning without also making reference to what is (to be) learned, and typically what we are aiming at in such considerations is some form of knowledge. Philosophers usually divide knowledge into three categories, defined as knowing-that, knowing-how and knowing-by-acquaintance. Williams and Standish (2015: 51) suggest that 'a typical reading of these categories is that philosophers draw a distinction between knowledge that is propositional (the kind of knowledge we have when we know that something is the case), knowledge that is about processes (when we know how to do something), and what is sometimes referred to as knowledge with a direct object (when we know something or someone directly or through immediate experience)'. (In this chapter I will not be addressing issues associated with this last form of knowledge.) This might indicate that these forms of knowledge are fundamentally different; in other words, that there are strong and impermeable boundaries between them. I want to suggest using a formulation from Robert Brandom (2000) that this is misleading, and that consequently some of the problems that these strong insulations have created can be resolved. This has implications for the theory of learning that I am supporting here and therefore for any curriculum theory that is proposed. I also want to suggest that, in society, these different forms of knowledge are given different

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statuses or have different attachments of importance, so, for example, vocational knowledge (broadly thought of as being about processes) is considered to be less important than academic knowledge (broadly understood as being about propositions), but these ascriptions of importance do not lie in the intrinsic nature of each knowledge form, but in the way that these knowledge forms are realised in particular societies.

A number of approaches (broadly thought of as foundationalist, instrumentalist and pragmatic) have been developed that have tried to answer the question as to what knowledge is (its function, its constitution, its genealogy and its rationale) and, though parts of these theories are understood as useful for the task in hand, on their own they do not amount to a complete theory of knowledge and therefore of learning. However, elements of each of these frameworks can contribute to a coherent and comprehensive theory of knowledge and subsequently provide a reason or set of reasons as to why a curriculum should include some items and exclude others, and what shape and form it should take.

A curriculum is always a selection from a range of cognitions, skills or dispositions that are available within a society; that is, these are being, or have been, manifested in human practices of a discursive, institutional, agential or embodied kind. Choices also have to be made as to how a curriculum is constructed – what relations are considered to be appropriate between the contents of the curriculum, its pedagogic forms, its learning strategies, and its evaluative criteria and apparatus. These choices of cognitions, skills and dispositions and the inferential relations between them (endogenous as well as exogenous), if they are to be considered reasonable, require a justification or rationale for them as curricular contents.

Knowledge then, is fundamental to these three types of learning: cognitive (relating to propositions), skill-based (relating to processes) and dispositional (relating to embodiments). Cognition comprises the manipulation of those symbolic resources (words, numbers, pictures, etc.), which points to (though not necessarily in a mirroring or isomorphic sense) something outside itself, though the referent might also be construed as internally related or, more specifically, as a part of an already established network of concepts (for example, cf. Brandom, 2000). Skill-based knowledge is different from cognition, because it is procedural and not propositional. Dispositional knowledge refers to relatively stable habits of mind and body, sensitivities to occasion and participation repertoires. Distinguishing between knowledge of how to do something, knowledge of something and embodied forms of knowledge is important; however, they are in essence all knowledge-making activities and furthermore, as we will see, can be formulated generically as acts of learning.

Robert Brandom (2000) suggests that acting in the world requires the use of, and is underpinned by, conceptual frameworks of one type or another. For him, propositional knowledge or making a claim that this or that is the case is, in common with the other two forms of knowledge, a process of doing and thus of knowing how to do something or other. And this results in all three types of knowledge having the same general form, and this allows them, in this form, to be understood as learning actions or acts of learning. '"Assertion", "claim", "judgement", and "belief" are all

systematically ambiguous expressions – and not merely by coincidence. The sort of pragmatism adopted here, by Brandom, 'seeks to explain what is assert*ed* by appeals to features of assert*ings*, which it is claim*ed* in terms of claim*ings*, what is judg*ed* by judg*ings*, and what is believ*ed* by the role of believ*ings* (indeed, what is express*ed* by express*ings* of it) – in general the content by the act, rather than the other way around' (his italics) (Brandom, 2000: 8). As a result, propositional knowledge-development activities are construed as individual processes that involve assertings, claimings, judgings and believings. This means that propositional knowledge is not thought of as fundamentally different from procedural and embodied forms of knowledge since assertings, claimings, judgings and believings are of the same order as riding(s) (a horse, for example), driving(s) (a car, for example), teaching(s) (a class, for example) or cooking(s) (a meal, for example). Note the way that these four activities are typically thought of as knowing-how processes, whereas the first four activities are usually thought of as knowing-that processes. However, what I am suggesting is that, in order to make a claim of knowing, we are not, as commonly thought, providing a description of an experience (i.e. constructing propositional knowledge) but making a claim about it in what Sellars (1997) has described as 'a space of reasons', and that what follows from this is that we can and should understand and use concepts specifically in relation to networks of meanings. Brandom (1994: 48) has described this as 'playing a role in the inferential game of making claims and giving and asking for reasons'. This characterises knowledge as social in character and historical in origin.

Any knowledge-forming activity, whether cognitive (knowing that something is the case, or, in Brandom's terms, judging that claim in term of its relations within and to a network of concepts), skill-based (knowing then how to do something) or dispositional (assimilating an action and being able to perform in the spaces associated with that action) needs a reason or set of reasons as to why the production of this form of knowledge should be preferred to the production of other possible forms. In order to provide a rationale or justification for these inclusions and exclusions, it is important to determine what that knowledge is and how it is constituted. This activity involves the acceptance of certain types of knowledge and the subsequent rejection of others. For example, knowledge which is understood as being determinate, rational, impersonal and predictive is fundamentally different from knowledge which is retroductively produced and referenced to a social world which is stratified, open and has ontological depth (cf. Bhaskar, 2010), and thus a belief in both of these at the same time is difficult to sustain. Another example refers to the nature of knowledge, and, in particular, whether it is individual or social. Standard epistemology construes the conditions for justified belief in individualist terms, rather than placing it within social contexts. This can be contrasted with social epistemologies (cf. Vygotsky, 1987), which prioritise the social over the individual.

Knowledge, whether the reference is to its essence, its legitimacy or its genealogy, is contested and therefore requires choices to be made between these different formulations, conceptions and arrangements. This in turn has implications for the types of pedagogy that should (normatively) be employed and the types of evaluative procedures that should (again normatively) be adopted. This is predicated on an

assumption that learning per se is always about learning something which might be called knowledge; binding knowledge and learning closely together, then, is an acknowledgement that knowledge can be declarative, procedural or embodied (though these are all subsets of one particular ordering: a particular type of relation between a person and an environment) and that in its production it can be construed as a learning activity. The next step is to examine the different knowledge perspectives that have been developed.

3.2 Foundationalism

A common argument that purportedly allows one to distinguish between legitimate and illegitimate items in a curriculum is foundationalist in orientation. Foundationalist views of epistemology were developed to combat the radical sceptic's argument that human beings can have no security in their beliefs about the world or that absolute knowledge is fundamentally impossible. If they subscribe to a relativist epistemology with the implication that this is all there is, that is, their descriptions of reality are relative to particular and specific time- and space-bound sets of ideas in the world, and if they further accept that it is not possible to make theory- or schema-free observational statements, then reality itself can have no restraining function on how they acquire knowledge of it, and what ultimately that knowledge is. This means that there may be a number of different ways of knowing the world and no means of distinguishing between them.

Classical conceptions of foundationalism insist that any justification for the truth of an educational proposition rest on identifying those sets of basic principles that underpin subsequent statements about the matter in hand, and the relevant inferences that allows the researcher to move from premise to conclusion. These basic principles or beliefs must be self-evident, and not in need of any further justification, if they are to qualify as foundational principles. This strong foundationalist view therefore comprises a process of identifying self-evident truths, which only those human beings with a defective perceptual apparatus cannot recognise. Note that these fundamental and self-evident truths are not subject to argument, development or agreement, except insofar as those advocating them might choose to exclude those they consider to have a defective sensibility; they literally present themselves to the normal person and provide the means by which a foundational structure can be built.

Epistemic foundationalism has two forms. The first of these is structural (cf. Williams, 2001), and this is where beliefs are said to be basic when no further evidence is needed to justify them, or those beliefs are inferentially connected to other beliefs which are either basic or not in need of any further justification. The second, substantive foundationalism, again according to Williams (2001: 164), has all the characteristics of structural foundationalism and, in addition, is epistemically basic, because such beliefs are 'intrinsically credible or self-evidencing'. What this means is that for a foundational belief to be substantive, it requires no further justification

and no further evidence to support it. In effect, it plays the end-role in any chain of justification, and there is nowhere else to go if such a justification is sought.

3.3 Instrumentalism

A different type of justification for the inclusion of items in a curriculum rejects these foundationalist principles and suggests that any rationale for the contents of a curriculum has to rest with some conception of what is trying to be achieved in the delivery of that curriculum. As a result, learners, having been through a process of successful exposure to this curriculum, are acquainted with certain designated types of knowledge, have developed certain designated skills, and have acquired certain dispositions, which, it is argued, allow them to lead a fulfilled life, and which also allow everyone else within that society to lead a fulfilled life. This justification is clearly normative and instrumental. What this implies is that a set of experiences can be identified which a person is exposed to and that these lead inexorably to the development of knowledge constructs, skills and dispositions which can be utilised by the individual outside of (in time and place) the learning environment. There are two principal problems with this approach: it is difficult to identify and reach agreement about what the good life for all is, or at least a life for all that allows everyone to be fulfilled; and there is an equal difficulty in identifying experiences that will lead to the development of knowledge constructs, skills and dispositions so as to allow the individual to lead a fulfilled life outside of the learning environment.

A range of instrumentalist curriculum rationales has been developed, and this includes autonomous instrumentalism, critical instrumentalism and economic instrumentalism. Instrumentalism denotes a view of the curriculum that makes reference to a future state of affairs for the learner that is external to the setting in which the learning is taking place. Autonomous instrumentalism refers to a view of the curriculum in which pedagogic arrangements, knowledge or skill orientations, knowledge framings, relations between knowledge domains, progression and pacing in the learning environment, relations between the teacher and learner, relations between types of learners, spatial and temporal arrangements, and criteria for evaluation are determined by the principle that the end-product is an autonomous individual, or at least an individual who is able to exercise their autonomy, even if they choose not to or are prevented from doing so. Critical instrumentalism, in contrast, as a rationale for a curriculum and its internal relations, seeks to eliminate from society sources of inequality and unfairness. The purpose is therefore indubitably normative. Economic forms of instrumentalism prioritise the economic over other functions in society.

These different versions of instrumentalism, though rooted in different value systems and educational rationales, have a similar form. There are three stages in their formation. A preferred vision of society and the conditions for the existence of such a society are identified. The role and purposes of the education system, and the contents and form that a curriculum should take to realise these ends, are clarified;

and finally, after the most effective means for the delivery of those ends have been identified, they are enacted, resulting in changes to existing curricular forms and subsequently to changes in society.

3.4 Pragmatic Arguments

A further rationale for the curriculum and therefore for knowledge in general is provided by those who subscribe to a pragmatist philosophy. There are a number of knowledge frameworks that broadly can be thought of as pragmatic (in a philosophical sense), including a form of inferentialism (cf. Brandom, 2000) that I have referred to already. Brandom (2000) distinguishes between pragmatist viewpoints and what he calls Platonist perspectives. The latter are understood as where the content of a knowledge claim resides in the relationship between the signifier, as typically in declarative sentences, and a set or sets of possible worlds. The former, though there are a number of different variants (cf. Quine, 1951; Sellars, 1997; Wittgenstein, 2001 [1953]), seek to explain how the use of these linguistic forms as they work in the world constitutes the meaning of them. Charles Peirce's (1982 [1898]) pragmatic maxim was that any theory of meaning takes as axiomatic that the content of a proposition is the experienced difference between it being true or false. Truth is therefore understood in terms of the practical effects of what is believed and particularly, how useful it is. The concept of usefulness is and can be used in a number of different ways; that is, making a set of propositions more coherent or consistent, or alleviating some need in the world, or fulfilling a personal desire, or moving from one state to another.

A further version of pragmatism is that something is true if it enables that person to say that this mechanism or sequence of activities will happen or can be sustained in other situations than those in which it is being applied. This points to the idea that something is true if it works; and this immediately presents itself as problematic, because a further justification needs to be provided as to whether what works is ethically sound or has consequences that can be judged to be ethically sound. Furthermore, any theory that incorporates an external element is realist in principle, even if this begs the question as to what type of realism is being advocated.

A final pragmatic justification, then, is that a rationale for including an item in a curriculum and excluding another rests on the consequences of it becoming a part of that curriculum and on how that curriculum operates in practice; so a judgement is made between two different items on the grounds that the one is more likely to be useful than the other. It should be noted here that an epistemic judgement (in the traditional sense, and where this refers to a true or false proposition) is being replaced by a pragmatic judgement about efficacy, though in this case a different type of truth theory is being invoked. As a result, it is possible to argue that an item should be included in the curriculum because it is more practically adequate; that is, human practices within which it is subsumed work in a better way as a result of its inclusion.

The issue still remains as to what might constitute successful work, or, to put it another way, what criteria can be used to judge whether the practical adequacy of one practice is superior to another. This can only be resolved by arguing that the one theory contributes to a better way of life than the other, and that this better way of life is determined by preferences of people in society and instantiated through current networks of power. The problem with this is that those sets of indicators that determine whether a theory is practically adequate may not be acceptable to those who hold a different and rival theory, and this therefore cannot form a basis for distinguishing between different theories except insofar as this is decided on the basis of asymmetrical power arrangements within society. Even here, it is not possible to say with any certainty that the one is more practically adequate than another as a result of current arrangements in society, because what those arrangements signify might be disputed and, in addition, they are likely to change over time. Philosophical pragmatists foreground the social in knowledge production, and it is therefore important to examine social theories of knowledge while also offering a critique of some of the problems inherent in these epistemologies.

3.5 Social Epistemologies

A number of social epistemologies have been developed, such as social constructivism, social realism and epistemic realism. The first of these is social constructivism. In opposition to a belief in a mind-independent reality, strong social constructivists avoid epistemic commitments, and locate justificationary rationales and apparatus in specific discursive formations, which cannot be externally referenced. The argument being made then is that all truth claims emanate from agreements or disagreements between human beings in the present and stretching back in time, which can be and have been only resolved by the exercise of power in society. Knowledge is the result of struggles in the past about the means for distinguishing true from false statements and, in the sense that the contingencies of history resulted in one such mechanism enduring at the expense of its rivals, knowledge comes into being. This social epistemology is generally challenged on the grounds that the issues surrounding epistemic relativism are not resolved in a satisfactory way.

A second framework is social realism. This is a philosophy developed in reaction to the excesses of social constructivism and, in particular, its irrealist assumptions. It parts company with social constructivism by its insistence that it is the social nature of knowledge (and this includes the way it is constructed, developed, given the status of theoretical knowledge, etc.) that allows theorists to make the claim that knowledge is justifiable. As a result, though knowledge has a social basis, this doesn't mean that it is being reduced to vested interests, the activities of specific issue groups, or even relations of power. Even if one accepts that knowledge production is not tied inexorably to the furtherance of particular vested interests, including the furtherance of cognitive interests, this doesn't mean that there isn't room for cognitive values which are independent of local power struggles; or that

there are no cognitive values relative to particular places and times or specific discourse communities; or that there are no means for determining that a particular curriculum is better than another; or even that there is no infrastructure for the production of knowledge which transcends time and place. The sociality of knowledge therefore does not undermine its objectivity, but is a necessary condition for that objectivity to be realised. Furthermore, if this view is correct, then knowledge processes such as differentiation, fragmentation, subsumption, progression and the like are key moments in its development, and thus key framing devices for understanding it and its legitimation.

However, what is central to this as a curriculum rationale is a belief that some knowledge is objective (and therefore should be included in the curriculum) in ways that transcend the historical conditions of its production. And this in turns means that it has to be possible to distinguish between those elements of knowledge that have been formed as a result of struggles within disciplines about legitimacy and form, and those that have not emerged in this way. This would seem to be impossible to achieve for practical reasons, and even then other curriculum rationales would need to be invoked, such as instrumentalist, epistemic or pragmatic justifications. What this argument is suggesting is that it is possible to identify a transcendental condition for the production of knowledge and the form that it should take. However, this transcendental condition necessarily has pragmatic and normative elements in the way that it is constituted, and therefore there would need to be an acknowledgement of these in providing a rationale for a curriculum.

A third position, epistemic realism, is qualitatively different. As Putnam (1990) has suggested, our conceptual frameworks, perspectives on the world and descriptive languages interpenetrate what is being called reality to such an extent that it is impossible to conceive of a pre-schematised world. This has a number of consequences for an exclusively representational view of knowledge; so, for example, the curriculum cannot be a simple representation (expressed as a series of facts) of what is out there in the world, because the world is not entirely separate from those mediating devices that human beings have developed to make sense of it, and this therefore means that in order to develop a curriculum rationale it is important to take account of those activities that can be called epistemic-to-ontic (i.e. knowledge of the world to being in the world) and ontic-to-epistemic (i.e. being in the world to knowledge of it) transactions. This has certain implications. The first of these is that a correspondence between a static intransitive world and an unchanging epistemic world misrepresents the nature of both and the relationship between them. Second, any attempt at describing the world always has the potentiality to change it, though not in every circumstance. Third, regardless of the accuracy or authenticity of the original set of descriptors and, as a result of this epistemic-to-ontic activity, those descriptors may become more accurate or more authentic. Though this suggests a one-way relationship, this is misleading. Those conceptual framings and sets of descriptors are informed, constrained and enabled in a non-trivial way by the world or reality at the particular moment in time in which they are being used, and in turn the structure of the ontological realm is influenced by the types of knowledge that are being developed.

Three general theories of knowledge have been examined in this chapter: foundationalism, instrumentalism and pragmatism, and each in turn was criticised: for an excessive focus in the first case on an essentialist view of knowledge and its divisions and a neglect of the transitivity inherent in the development of knowledge within the disciplines; in the second case on knowledge being treated as provisional, contingent and arbitrary, and curricular knowledge being identified exclusively in terms of specific social goals; and in the third case, on an unwarranted emphasis on the sociality of knowledge development and learning, without at the same time providing any transcendental grounding of knowledge in reality. However, elements from each of them, for example, the inclusion of a social dimension to knowledge production, even if this doesn't categorically preclude reference to a world that is separate from the way it is being described, can be harnessed to produce a transcendental (i.e. beyond common thought or experience) view of curricular knowledge. Conceptual framings and sets of descriptors are informed, constrained and enabled in a non-trivial way by the world or reality at the particular moment in time in which they are being used, and in turn the shape and form the ontological realm takes is influenced by the types of knowledge that are being developed. Any knowledge claim has to be placed within the space of reasons (cf. Sellars, 1997), which means that this claim is discourse-specific and positioned within conceptual frameworks that precede it in time and place and have implications for future use.

3.6 Interdisciplinarity

I have already suggested that knowledge has three functions in the development of a curriculum. First, it can provide a rationale for the shape, form and contents of that curriculum. Second, it can provide the content for a curriculum, that is, those constructs, skills and dispositions that the curriculum maker, education system provider or nation decides are the most important and relevant for the learner. Third, since learning is a knowledge development activity, and a curriculum is understood as an intentional programme of learning, then knowledge is central to the construction of a curriculum. The issue then of what knowledge is, its justification, constitution and rationale, becomes a concern. If knowledge is understood as disciplinary based, then the mode of production and justification is located within a discipline. If knowledge is understood as interdisciplinary or transdisciplinary, then its mode of production and justificationary rationale is located in the spaces between different academic disciplines or outside those different academic disciplines altogether. What this also means is that disciplinary knowledge, discipline-derived rationales for the curriculum and discipline-based curriculum contents are, in some important ways, insufficient and inadequate.

The existing literature on interdisciplinarity is overwhelmingly epistemologically slanted. Typically absent from it is any discussion about what there is in and about the world that makes interdisciplinarity and consequently transdisciplinarity possible and necessary. There is therefore a need to focus on ontological as well as

epistemological considerations and, in particular, when that focus is the curriculum. This requires the identification of barriers to interdisciplinarity as a feature of the knowledge theory that inevitably underpins the development of any curriculum, as well as the development of transdisciplinary constructs as features of this curriculum. And this in turn is to understand knowledge, its development and its derivative capacity as having ontological dimensions, and as being more than what is produced by and in the disciplines.

It therefore follows from this that almost all applied knowledge development, such as the development of a curriculum, necessitates interdisciplinary and transdisciplinary processes of one type or another. The formal conditions for this depend on both complexity and emergence, and since emergence is a universal feature of human life, all applied knowledge development which is concerned with human beings, or about any part of the world which is affected by human beings, will necessarily be both interdisciplinary and transdisciplinary. These are therefore not optional extras or afterthoughts but, rather, must be understood to be a necessary condition of knowledge development from the outset, such as in processes of curriculum development. The conditions analysed and thematised here are not just conditions for a special kind of knowledge development, but are conditions for all research and knowledge development, including curricular knowledge.

Furthermore, the conditions for interdisciplinarity and transdisciplinarity work are presupposed by a great variety of other social practices, including, for example, our ordinary material transactions with one another and nature, and by our explanatory activities in everyday life; that is, by our attempts to explain, influence and change the world. Thus, getting clear about the conditions for success in interdisciplinary and then transdisciplinary knowledge development (the former is a precondition of the latter) is also a precondition for (and provides clarity about) practical rationality.

The development of a curriculum – a work-based and practical rationality problem – therefore can be thought of as having a number of sequential stages. The first of these is the development and application of a theory of interdisciplinary and transdisciplinary knowledge that underpins the educational programme being developed and from which is derived a set of knowledge constructs, skills and dispositions, which the members of a society or system consider to be appropriate, now and in the future. From these a set of pedagogic standards can be derived. Knowledge is transformed at the pedagogic site, so it is possible to suggest that qualities such as: the simulation of the learning object, the representational mode of the object, its degree and type of amplification, control in the pedagogic relationship, progression or its relations with other learning objects (i.e. curriculum integration), the type of pedagogic text, relations with other people in the learning process, the organisation of time (temporal relations) and types of feedback mechanism are fundamental components of this pedagogic transformation. What this means is that, in the learning process, the learning object takes a new form as a result of changes to its properties: simulation, representation, amplification, control, integration, textual form, relations with other people, time and feedback. In contrast to some frameworks, that is, Bernstein's (2000) sociolinguistic code theory or Maton's (2014) knowledge and

knowers thesis, the sheer complexity of the possible pedagogic knowledge forms that this allows means that relations between pedagogic arrangements and social arrangements, and between these pedagogic arrangements and notions of identity-formation and social positioning, can only be tentatively sketched out, if at all.

In the first instance then there is a need to develop a theory of interdisciplinarity. A general theory of interdisciplinarity is distinctive for two reasons. First, it focuses on ontological as well as epistemological considerations (and grounds for interdisciplinarity). This is enabled by a reinstatement of ontology, and a critique of the reduction of ontological to epistemological concerns in the epistemic fallacy (Bhaskar, 2008). Second, it brings to the fore a differentiated and stratified, non-Humean and non-reductionist view of the world. This involves a critique of actualism, or the reduction of natural laws to their instances or empirical grounds. On this, the move from manifest phenomena to underlying generative mechanisms and structures lies at the heart of scientific discovery.

The ontological case for interdisciplinarity begins with the consideration that, outside a few experimentally (and even fewer naturally occurring) closed contexts, a multiplicity of causes, mechanisms and potentially theories is always involved in the explanation of any event or concrete phenomenon. However to get from multi-mechanismicity to interdisciplinarity and thence to transdisciplinarity, we have to add considerations of emergence to those of complexity. Briefly, an emergent level of reality is unilaterally dependent on a more basic one; taxonomically irreducible to the more basic one; and additionally, causally irreducible in the domain in which the basic one operates (Bhaskar, 2010). If such emergence is involved, then the characteristic multi-mechanismicity of open systems will have to be studied in a multidisciplinary way, that is, by (or from the perspectives of) a multiplicity of disciplines. Furthermore, if, in addition to an emergent level, a qualitatively new or emergent outcome is involved in the causal nexus at work, then the knowledge required can no longer be generated by the additive pooling of the knowledges of the various disciplines concerned, but requires a whole integration or genuine transdisciplinarity.

3.7 Transdisciplinarity

The philosopher, Martin Heidegger, has argued that representational epistemologies (including correspondence theories of truth) are deficient (cf. Heidegger, 1978). This therefore requires a move to adopting epistemologies that in essence or appearance are not representational or disciplinary-focused, and indeed what this means is that the whole concept of epistemology, as it is generally understood, becomes redundant, as some people have argued (cf. Taylor, 1989 – as soon as one moves away from representationalist forms of relations between knowledge of the world and the world itself, then epistemology as a separate form becomes redundant). This is the route that Heidegger takes. He wants to replace it in the first instance with a notion of foregrounding. The text (understood in its widest sense), and the way in

which it is read and received, are embedded in history. Heidegger (1927 [1962]: 191) points to the 'fore-structure' of interpretation, and he means by this that an interpretation is never 'a pre-suppositionless apprehending of something presented to us', but always involves a 'fore-having', 'fore-sight' and 'fore-conception'. Historical texts are therefore read in terms of their pre-texts; each society has its own way of organising language, other activities, discourses and writing, and thus any historical text has a form that is unfamiliar to the reader. Furthermore, each text has a sub-text, which operates beneath the text, but which gives it its meaning: those epistemologies and traditions of knowledge that are historical and which permit a particular reading. This therefore requires a disclosure. The second move that Heidegger makes is even more crucial, and this involves a repudiation of the disengaged self and the punctual self (cf. Taylor, 1989). We are beings (*Dasein*), always in the world, as agents engaged in realising a particular form of life. This is what we are about, as Heidegger puts it, *first* and *mostly*. The third move is to locate all of this within a metaphysical notion of Being (being in Being).

Now, it has been claimed that one of the implications of this is that, if we adopt a way of thinking that is located in the disciplines (disciplinarity), then the subsequent knowledge (and being) that we produce is inadequate or faulty in some way or another. Heidegger famously identifies a form of thinking, calculative thinking, which is wholly injurious to the world and in tension with his notion of being in Being. With regards to interdisciplinarity, there is a problem with the notion of combining qualia from different disciplines in a harmonious way, for example, that a research project should include both quantitative and quantitative methods of data collection, because the higher level of knowledge construction may include a repudiation of the lower level. And if we accept this, then the highest level of all, transdisciplinarity, is framed in foundational terms and not, as it should be, in some sense as an extension, completion or perfection of framings at lower levels, though one may have to go through the lower levels to get to the higher levels. Heidegger argues that it is not through science but an ontological understanding, revealed through mood, that the totality of Being is unconcealed.

In this chapter, I have focused on knowledge and its variants, and made the point that if we are to understand what a curriculum is and could be then we also have to understand how knowledge is and can be construed. This has involved the making of a claim (a claiming) that knowledge and knowledge development have certain constituents and thus are this rather than that. This therefore constitutes a repudiation of certain viewpoints about knowledge: for example, disciplinarity, propositionality in its traditional form, representationalism exclusively (the conceptual contents of a knowledge claim are not only inferential in kind), foundationalism and instrumentalism. These are important first moves in identifying and constructing a higher education curriculum.

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Chapter 4
Transdisciplinary Thinking: Pedagogy for Complexity

Paul Gibbs

> *The fields of the sciences lie far apart. Their methodologies are fundamentally different. The disrupted multiplicity of disciplines is today only held together by the technical organisation of the University and its faculties, and maintained as a unit by the practical aims of those faculties. As against this, however, the root of the sciences in their essential ground has atrophied.*
>
> *Heidegger*, What is Metaphysics (1949)

4.1 Introduction

We think as scholars, as educators and in many other different ways, but do we ever consider what it is to think? Should we, as Heidegger suggests, be 'ready to learn thinking' (1968: 3)? I answer this affirmatively and suggest that doing so opens up the potential of transdisciplinary thought, thought which both transcends and is more primordial than disciplined knowledges in an age of complexity and anxiety. I do this by first introducing a structuring of transdisciplinarity to ground this discussion. I then consider how this thinking might structure our pedagogical practice by briefly considering three orientations to thinking: Kant's rational thought, Heidegger's inceptual thought and Confucian performative thought. I do this with the help of Nicolescu, but do not hold him accountable for my interpretations.

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4.2 Background

There is a strong bond, historically, between the field of philosophy and the university as an institution for higher education and thinking. Rather contentiously, it is the philosopher who seeks *aletheia*, an unconcealing of what is essential truth, not the scientist or engineer, and perhaps it is to philosophy that we owe our anxiety and to science our comfort in the process of finding clarity. However, we can find such clarity not just in the ratio-deductive methods, but also in the poet's use of metaphor and in the mystic's meditation. The entrapment for thought in forms of logic has led to calculative thinking, the fracturing of discourses of wisdom, and dislocation of values and emotions from thought. Throughout Kant's writing, this element of thinking and thought is inextricably linked to a more general educational spirit, the notion of '*Bildung'*, or formation, and was notably challenged during the twentieth and twenty-first centuries in the philosophies of Charles Peirce, Martin Heidegger and Basarab Nicolescu. At stake was, and is, the notion of thought, in a philosophical sense, in close union with social virtues, societal ethics and existential reflection. Lyotard's depiction of the academy, as legitimated by the principle of 'performativity' (1984) in the wake of a dissolution of 'grand narratives', was a further indication of a loss of large frameworks of thought that were alleged to be associated with postmodernism. This more critical line can be traced back even to Heidegger who, in the opening lines of his book *What is Called Thinking?* resolved that ontological accounts of the process of thinking as reasoning prove unsatisfactory and, it can be argued, that thinking should be construed as some kind of practice. He commented that we 'come to know what it is to think when we ourselves try to think. If the attempt is to be successful, we must to ready to learn thinking' (1968: 3).

The hegemony of universities, however, is being contested, not only over the *range* of thought that they now favour, but over their tacit value-orientation and even over what is to count as thought itself. In the internet age, after all, thought is liable to be reduced to the mere assembling and handling of data rather than the creation of new and critical frameworks that might place humanity in a new relationship with the world.

I hold that the element of thought and the ability to think in a deep and groundbreaking way are still the essence of the university. But what does it mean to think in the university today? And in what ways is thought related not only to the epistemological and ontological issues, but also to social and political dimensions of our globalised age?

4.3 A Grounding of Disciplinary Engagements as Cultural Knowledges

For Heidegger, the creation of rigid disciplinary distinctions facilitated by calculative thinking concealed the real nature of objects and beings. This metaphysically based mistake ensures both that the disciplines continue to seek but never find the essence of what one is investigating. In no small part this is an emergent upon the form of epistemology. The job of a Western metaphysical epistemology is to hide true meaning by preventing its revelation, for metaphysics grounds intelligibility. Heidegger states, 'when epistemology thus sees and so posits environmental experience, then it destroys it in its meaning and takes it as such into theoretical context. It sees theorised reality as the reality and in this way tries to explain environment reality' (2008: 73). As Shepherd (2016) observes, for Heidegger the methodological suppositions reveal the specific truth only of the methods used. There is a paradox here, for although in an epoch that has seen significant progress in the fields of scientific knowledge and technology, we still have problems that seem unanswerable by the application of rationality when it is constrained by the politics of knowledge. This, as Morin articulates, has produced a 'new kind of blindness to complex, fundamental, global problems, and this blindness generated countless errors and illusions, beginning with the scientists, technicians, and specialists themselves' (1999: 19).

For Heidegger, this is one manifestation of the technological enframing of our world, from which universities are not exempt. Heidegger offers a powerful critique of the way in which our educational institutions have come to express a nihilistic, 'technological understanding of being'. In his lecture, he pronounces the death of the higher education institution, proclaiming that 'The rootedness of the sciences in their essential ground has dried up and died.' Yet, as Thomson points out, by 'this deliberate provocation Heidegger is not beating a dead horse; his pronouncement that the university is dead at its roots implies that it is fated to wither and decay *unless it is revived*, reinvigorated from the root' (2001). Thomson notes that early endeavours to create a university that would 'dissolve the concealments disciplinary education had engendered in order to recover originary conditions of learning' (Thomson, 2001).

As Shepherd (2016) claims, Heidegger conceived of a context which promoted student questioning without being too immersed in instrumental conclusions. In such circumstances, disciplines would still be conducted of value, but would be understood in terms of their inherent horizons. It is in this making more conspicuous the constraint of discipline-based knowledge that education could come closer to self-awareness. (This is the project I claim for transdisciplinarity.)

To foreground this discussion of transdisciplinary thinking, I briefly offer how I think about the epistemological relationship of disciplinarity, interdisciplinarity and transdisciplinarity at three levels. Disputes about the nature, value and rationales of academic disciplines are not new, yet they continue to structure a world into parts, developing barriers to understanding the whole. Indeed, Nicolescu argues that

complexity is nourished by the disciplinary boom, which in turn leads to the accelerating proliferations of disciplines (2014: 99). He refers to this as the epoch of 'technoscience' (2014), which has resonance with Heidegger's technological way of being, where we have lost spirituality in favour of economic powers.

The ontological case for interdisciplinarity begins with the consideration that, outside of a few experimental (and even fewer naturally occurring) closed contexts, a multiplicity of causes, mechanisms and, potentially, theories is always involved in the explanation of any event or concrete phenomenon. This is an index of the complexity of the subject matter. However, to get from multi-mechanisms to interdisciplinarity, and thence to transdisciplinarity, we have to add considerations of emergence to those of complexity. Briefly, an emergent level of reality is: (i) unilaterally dependent on a more basic one; (ii) taxonomically irreducible to the more basic one; and, additionally, (iii) causally irreducible in the domain in which the basic one operates. If such emergence is involved, then the characteristic multi-mechanisms of open systems will have to be studied in a multidisciplinary way; that is, by (or from the perspectives of) a multiplicity of disciplines. If, in addition to an emergent level, a qualitatively new or emergent outcome is involved in the causal nexus at work, then the knowledge required can no longer be generated by the additive pooling of the knowledges of the various disciplines concerned, but requires a synthetic integration or genuine transdisciplinarity. This is not reducible to disciplinarity or interdisciplinarity, though it is emergent from them. There is a radical incommensurability between disciplinarity and interdisciplinarity, and interdisciplinarity and transdisciplinarity based on emergent realities. These realities are encountered as laminated totalities, difficult to penetrate and giving the impression of oneness. Yet this lamination, when unconcealed, gives the liminal spaces for logic free thinking of the type of Nicolescu's resolution of the third logic axiom, by the introduction of the 'included middle' to retain the use of generalised logic in what Heidegger calls 'the science of thinking' (1992: 1). There is a similarity in this approach to the seminal work of Jantsch's (1970) systems approach of the university as a transdisciplinary element in the cybernetic system of education and innovation.

How this development of transdisciplinarity relates to disciplines is not clear. For example, does this mean that *all* work produced in each and every discipline is in some way flawed? With regards to the next stage, interdisciplinarity, there is a massive problem with the notion of combining qualia from different disciplines in a harmonious way. Transdisciplinarity has to be framed in foundational terms and not in some sense as an extension, completion or perfection of framings of other levels. Such an approach does not look to hegemonies of knowledge to redefine problems away from their context, but to locate them within both a local and global context and use the learning from them to inform a wider engagement of dialogue. This is one of emotional, spiritual, tacit, contextual, traditional, tribal, imaginative, patterning and reflective praxis, rather than one based on metaphysical thinking and rational judgement. In this sense, there is a similarity with Brown's (Brown, Harris, & Russell, 2010) patterning of knowledge cultures as a nested system.

4.4 An Addition and Alternative to Induction and Deduction

For Peirce, abduction comes to us 'like a flash. It is an act of insight, although a very fallible one' (1998: 227). It works, according to Peirce, when a *surprising* observation is surprising, because of the nature of that which had been taken as truth and that cannot now explain the new observation. Such inquisitiveness to examine the new observation may be restricted by a world view that is looking for similarity rather than difference. Moreover, it is the search for this form of insight, when the disciplined solution is inadequate, that leads to the pragmatic *phronetic* understanding of complex situations in order to act in a specific, morally justified way; to solve a problem without recourse to a single theoretical paradigm. It is about making judgements of practice and producing practical knowledge that can challenge power in ways that inform real efforts to produce change (Schram, 2012: 20). Bybee suggests that 'abduction allows us to infer new information, it also enables us to use it as evidence to justify a conclusion. In other words, abduction has a rhetorical as well as logical forces' (1991: 293/94). Moreover, its ability to persuade 'depends on how readily its audience can think of a conclusion different from the one the argument advances to account for the initial conditions' (ibid.: 296).

This approach is warranted, as the abductive information is not safe from fallacies. These fallacies can be managed in the specific abductive case study, if more attributes can be revealed. For example, the moon looking like green cheese is insufficient for the proposal to gain any credibility. The suggested approach in the case study mode of investigation is to use abductive reasoning to formulate understanding, which leads to persuasive resolution of problems by utilising, but not presuming, a discipline-based solution. It is thus not pitted against disciplines, but privileges the reasoning of the abductive case study above a body of knowledge and its associated epistemology. It is plausible as an approach to building a research approach to solve real and complex problems within our world space. It provides an engagement that allows a reasoning that is not merely an end in itself, but rather a means to regain unity beyond the boundaries and plurality of disciplines. Yet, it may still lack a formal, layered structure to the reality that it investigates. Such layers might be found in a rhizomatic framework and may be found in exploration, for example in critical realism. The proposal, then, is to retain the value-laden principles of *phronetic* analysis, yet to frame the analysis in such a way as to connect the cases to the real world through the networks of transdisciplinary insight at work in the flux of social reality revealed through critical realism.

This is clearly not the only approach that might be used for transdisciplinary knowledge. Scholz and Tietje (2002) wisely advocate caution, and Stauffacher et al. (2006), especially, provide a 'learning framework based on what we call functional socio-learning' (p. 253).

4.5 Heidegger on Thinking and Releasement

Heidegger focused not on the being of being human, but an exploration of what is the Being of everything. This is clear in *Being and Time,* where he suggests that only an investigation into the fundamental ontology from which all other ontologies must spring, an inquiry into the foundational sense of being, yields an existential analysis of *Dasein*. He states that the 'analytic of Dasein remains wholly oriented toward the guiding task of working out the question of Being' (1962: 38). He thus confers a special status on humans to review the nature of Being. This theme continued, and in *Letter on Humanity* he writes that a 'human being is the shepherd of being' (1998: 252).

From the quote from *What is Metaphysics* opening this article, it is evident that Heidegger's view was that formalised and structured scientific investigation does not illuminate, but adds opacity to the essence of Being. This is because failure to concern the world in its totality for disciplines can, at best, provide only limited revelations, constrained and shaped by the rituals and truth claims of their collective world views. Heidegger argues that it is not through science but an ontological understanding revealed through mood that the totality of Being is unconcealed. He began to offer us a distinction between disciplines: inter- and multidisciplines and transdisciplinarity, which will be developed later. From a Heideggerian perspective, knowledge organised by discipline leads to a refusal of the totality implicit in the calculative and sanctioned thinking of these disciplines.

It is in Heidegger's works after *Being and Time* that I will focus this discussion, specifically his extensive explorations into thinking and willing/non-willing in *Conversation on a Country Path*. In this text, Heidegger offers a process on how we train ourselves to think other than metaphysically (1966a). This work is an imaginary triadic conversation between a Scientist (disposed to calculative thinking), a Scholar (a metaphysical thinker) and a Teacher (the voice of Heidegger as a thinker of thoughts). The focus becomes the understanding revealed in the act of the dialogue rather than what is actually said; not in a linear manner, but through hermeneutic circles. This work has seemingly direct metaphorical links between the 'way' of Confucianism and the path. Consider the following extract from the *Conversations*:

> Scholar: From this it suddenly becomes clearer to me how movement on a way [*Be-wegung*] comes from rest and remains engaged in rest.
> Teacher: The releasement would not just be the way [*Weg*], but rather the movement (on the way) [*Bewegung*]
> Scholar: Where does this strange way go, and where does the movement befitting it rest?

Its feel and structure have the appeal of an ancient Chinese philosopher seeking understanding from a discussion with a Teacher; that is, Confucius in the *Analects*.

The dialogues in the *Conversation* have two central themes. The first is the 'open-region', which is both the place of being and where beings can be with one another in a 'topology of being'; the second is a critique of the willfulness of representational thinking and 'a search for a way of releasement from its grip and into authentic, non-willing manner of thoughtfully dwelling within the open-space

of being' (Davies, 2010: xiii). This concept, especially the discussion of awaiting rather than awakening thinking, creates a transformative way of thinking that opens a way to understanding transdisciplinary thinking.

Indeed, there is a certain spiritual feel to Heidegger's work that might lead one to consider an onto-theological stance, a requirement for a cosmological entity from whom all is understandable. Heidegger foresaw danger in humanity's reliance on calculative thinking (and its manifestation in machination) that prompted his comment in his 1966 *Der Spiegel* interview, 'only God can save us' (Wolin, 1993: 91).

Heidegger's conversations try to break from the metaphysical and physical to reveal a way of thinking unlike formal metaphysical questioning, but as onto-epistemological enquiry. For Heidegger, metaphysics' failure is that it enquires into the being of human beings, not into the notion of Being – on which being is contingent. For him, this 'Being' is the fundamental ontology representing a thread running through much of his early work and leading to his more poetic, even mystical, later contributions (Young, 2002). His struggle is hampered by the use of forms of thinking designed for the understanding of being in its enframement of a technological way of being, especially the calculative thinking that encourages nature, including humans, to be seen as resources in the gift of those in power. His insistence on thinking on Being at the core of our understanding of human being began to resolve itself in language that is more poetical and mystical to understand Being.

Allowing understanding to emerge, unshackled, from forms of logical, rational investigation opens up new realities and new truths. Moreover, it allows letting the nature of Being of things come into the context of the present as a totality of Being. Heidegger commented that '(M)an is obviously a being. As such he belongs to the totality of Being – just like the stone, the tree, or the eagle' (2002: 31). This thinking is essentially meditative and can be considered metaphorically as 'the activity of walking along a path which leads to Being' (1966b: 25). Further, it requires a releasement (*Gelassenheit*) of that which enframes and defines the characteristic of man's nature. Releasement seeks the equanimity to allow technology into our lives, yet also to resist it. It creates the context of meditative or 'inceptual' thinking (Heidegger, 1999) as an alternative to calculative thinking that defines and measures reality.

Releasement is a central theme for the later Heidegger, and is first discussed in his *Memorial Address for Kreuter* (1996). Its reliance is on the notion of meditative thinking, which Heidegger counterpoints against calculative thinking. He argues that meditative thinking is as difficult as any other and concerns us in 'what is closest; upon that which concerns us, each one of us, here and now; here, on this patch of home ground; now, in the present hour of history' (ibid.: 47). It is about contemplating what this might mean to self and humanity. It is not willed thinking (and it links to the essence of being, as he discusses regarding the work of Nietzsche, 2012), and allows an openness to things; it is open-systems thinking across barriers and between ideas.

This might be reframed as transdisciplinary thinking, as it engenders a comportment, a way of being, that allows the meaning of change to be. As Heidegger reports, 'profound change is taking place in a man's relationship to nature and to the world.

But the meaning that reigns in this change remains obscure' (ibid.: 55). Moreover, Heidegger refers to this comportment as 'openness to the mystery' (ibid.), and that the releasement and the mystery belong together to offer ways to take an autochthonous stand in the contemporary world. This is to think poetically; this is a way that overcomes the representational horizon-bound thinking of the philosophy of our revealed world. Meditative and poetic thinking allows us to grasp the ungraspable (Young, 2002: 19).

4.6 Transdisciplinary Pedagogy as a Patterning of Thinking in Complexity

Education creates uncertainty, so learning involves searching and struggle, and admits to doubts and to forms of despair. For Heidegger, it is the practices of the modern world and modern technology that produce a different kind of subject – a subject who does not simply objectify and dominate the world through technology, but who is constituted by this technology (Dreyfus, 2002), although Joseph Brenner has stated that transdisciplinarity is a 'method for thinking about the relations and implications between human actions and events and about how to include emotional, artistic and philosophical elements in discussion of solutions to practical problems' (2014: 4). With due respect to the revolutionary thinkers on the object of transdisciplinary thinking (e.g. Nicolescu, Brenner, Ertas and Drugus), I suggest that transdisciplinary thinking here, and in other works, concerns what is to be thought about, not the nature of the thinking, which remains wedded to calculative rationalism, so they fail, I think, to point to how we might do transdisciplinary thinking.

This suggests a link with Confucius, Heidegger and Nicolescu that can also be used to propose an illumination of the transdisciplinary ideas which might lead to a transformative way of teaching: a way which refuses to allow the teacher to be just technician in a Foucauldian sense of 'telling the knowledge he possesses and the truth he knows, because this knowledge and truth are aligned to a whole weight of tradition' (2011: 23). This involves no substantial personal risk of enquiry or of change in the light of evidence. Those who have become the powerful in this age of machination – the heads of professions, the heads of discipline-based disciplinary bodies and the controllers of the digital age – establish a self-interested filiation in the domains of knowledge so as to divide to rule; just observe lawyers and accountants, or doctors and social workers trying to work together! Brewer encapsulates this argument when he declares that the 'world has problems, but the universities have departments' (1999: 328). To think and speak out beyond the hegemonies which are mediated through the universities changes us from technicians to parrhesiasts. A parrhesiast risks everything to tell the truth as he or she sees it, and there are some within the ranks of this academy. Nicolescu offers such thinking in seeking

an understanding of our being cosmologically within the constraints of an integrated system.

This awareness requires changes to the way in which we conceive education and the ideas of institutional study in terms of thinking and teaching. Moreover, as Foucault argues, to develop a way of caring for oneself and for others 'implies also a relationship to the other to the extent that, in order to really care for self, one must listen to the teachings of a master. One needs a guide, a counsellor, a friend – someone who will tell you the truth' (1987: 118). As Peters suggests, this leads to a 'cultural significance of truth-telling as a set of educational practices' (2003: 218). With respect to Nicolescu's notion of instilling complex and disciplinary thought into 'the structures and programs of the university [which] will permit its evolution towards its somewhat forgotten mission today – the study of the universal' (2002: 140) leads to a renewed university which would become the place for 'welcoming a new humanism' (ibid.). For Nicolescu, 'learning to be' involves discovering our conditioning, the harmony or disharmony between our individual and social lives, and testing the foundations of our convictions. Confucius, I suggest, helps here as, for him, thinking is not an abstraction from the world by practical and performative activity, activities with a practical result. These activities are, as Hall and Ames (1987) suggest, fundamentally integrative, and which seek to maximise the thinker's potential.

It is an ongoing invitation to think, and not in the sense that Heidegger says that 'science does not think'. In this quote, Heidegger's view is that formalised and structured scientific investigation does not illuminate but adds opacity to the essence of Being. This is because failure to concern the world in its totality for disciplines can, at best, only provide limited revelations that are constrained and shaped by the rituals and truth claims of their collective world views. As Davis suggests in his introduction to Heidegger's *Country Path Conversations*, 'modern and scientific thinking is characterised as a wilful representation, an objectification that transcends – climbs over – things to determine a transcendental horizon which delimits the forms through which things can only appear as objects to subjects' (Davies, 2010: x), or 'which sets forth nature as object, shows itself as a human attack on nature' (Heidegger, 2010: 11). It is as if thinking beyond the horizon of established modern concepts is limited by the conceptual notion that gives rise to the representational world that we take as reality. Even the notion of data from these disciplines has a particular epistemological and methodological structure.

For Heidegger, the student–teacher relationship is not conceived as a vehicle for the attainment of some authoritarian engagement – what is, in in effect, a management tool – but as a genuinely creative encounter in which the lecturer senses the quality of the learning event. This strikes a sharp contrast with the effective thinking in the calculative mode. For Heidegger, learning to think is conceived as mystery and wonder. It is based on trusting that perceives the integrity of the learner and the lecturer. The essence of inceptual thinking, then, is in the unfolding of the world in wonder rather than attempting to control it. This thinking is non-conceptual; neither does it require concepts to enable us to think, but it does require us to have the openness to the world to do so. It is the thinking that Heidegger refers to as 'releasement'

in his latter works. The focus becomes the understanding revealed in the act of the dialogue of the unfolding moment, rather than what is actually said, not in a linear manner but through hermeneutic circles. This seemingly has direct metaphorical links between the 'Way' of Confucianism and the path. It is about waiting for what it is, in the event, that needs to be thought, rather than the awakening to thinking, and creates a transformative way of thinking that opens a way to understanding transdisciplinary thinking. His struggle is hampered by the use of forms of thinking designed for the understanding of being in its enframement of a technological way of being, especially the calculative thinking that encourages nature, including humans, to be seen as resources in the gift of those in power.

4.7 Poetic Thinking Is the Thought of Transdisciplinarity?

The more our use of language widens the limits of our mind and thus of our world, the more it is poetic. Poetic comes from *poiesis*, to make/create. In this, disciplines can merge under the rubric of 'disciplines of meaning' if the technological enframement of language if lost and the freedom to speak the truth as it appears is awoken. Moreover, Bonnett (2002: 239) suggests that 'poetic learning is an ever-evolving triadic interplay between teacher, learner and that which calls to be learned'; thus poetic thinking generates its own context-relative interpretation that expresses a receptive-responsive openness to things. This might be explored through a dynamic cybernetic-semiotic system.

Curriculum *is* semiosis, where the semiotic is not just a matter of communication, but is the actual formation of human being continually (trans)forming human being anew. The cybernetic aspect of modelling amounts to envisaging learner–teacher communication as a whole feedback loop, where the source of information becomes a destination when it is fed back, and where the destination of information becomes a source as it feeds back information to the original source. The systemic aspect of this model is that 'control' of information is distributed and resides in the whole system, rather than just one element of it. It requires the lecturer to be unsure of his or her ground, because it cannot be specified in advance and because such thinking is rhizomatic (Deleuze & Guattari, 1983), rather than thinking by seeing, and creating categories constrains our temporal liminality. The semiotic aspect amounts to not reducing the 'information' exchanged to discrete elements, but as signs whose meaning is subject to several intermingling constraints (ecological, physiological, emotional, observational constraints) and types of contexts.

So, to poeticise thinking, as *poiesis*, our pedagogy needs to respect the onto-cosmology of our being developed through different modes of thinking. Our pedagogical practice would be transformative, transdisciplinary and realised as a dynamic semiotic system. These practices need to let students learn about being in the world and, indeed, change what they find. Poetic thinking is transdisciplinary

thinking and shifts from concepts that objectify and fall prey to reductionism to those that creatively and connectively point out difference, not to compare against but to celebrate. It is thinking which liberates from the categorical constrains of disciplines, and connects and diversifies as possibilities are produced. These processes are far from linear; and, because people constantly move from one state into another, the results are far from predictable.

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Part II
Contexts for Transdisciplinary Practice

Chapter 5
A Transdisciplinary Approach to Postgraduate Research Education: Challenges and Strategies

Barbara Hawkins

5.1 Introduction

Recent innovations in research funding in the UK suggest that there has been recognition that transdisciplinary research projects that draw together insights and approaches from several established disciplinary areas can more readily address the challenges and questions of contemporary society (RCUK, 2011). Such recognition offers novel opportunities for researchers, perhaps particularly so for those at an early stage in their academic careers. In this new environment, it becomes relevant to consider in what ways we might better support and guide our early-career researchers and doctoral students to enable them to take full advantage of the wider range of research opportunities that now exist.

To date, however, transdisciplinary research training is by no means a significant activity within most doctoral programmes, while the research council schemes themselves offer only limited opportunities for research students to network and share research across disciplines (Lyall, Bruce, Tait, & Meagher, 2011). For postgraduate students in particular, the provision of contemplative intellectual spaces in which they can explore transdisciplinary discourses and discovery can play a key role in helping them to take full advantage of emerging research themes.

These discourses do not happen by chance. In established disciplinary areas, pedagogic traditions are strongly linked to research methodologies and practices that lie at the conceptual heart of each academic community's history. Consequently, for most students, their subject discipline becomes not only their primary source of ideas, methods and materials, but also fundamentally influences their ways of seeing, forms of understanding, learned work practices and styles of communication. Creative opportunities to seek out collaborators, practitioners and audiences from other fields of enquiry occur only rarely – particularly during undergraduate study,

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but often still discouraged by supervisors at postgraduate level. Some suggest that our universities are 'mal-adapted' for adjustment to the new situation that transdisciplinary discourse demands, and that our current degree and diploma structures are designed for a world that 'no longer exists' (Malina, 2013a: 5). To become effective transdisciplinary researchers, students need to learn new etiquettes, languages, methodologies and modes of interpretation that are inflected within the perspectives of different academic environments and cultures, in particular, perhaps, across the domains of the arts and sciences. In an editorial in the journal, *Leonardo*, Malina (2013b) refers to the need for 'mobile professionals' who can navigate in transdisciplinary practices and who operate as hybrid translators of ideas and solutions to global issues.

What does this imply in terms of providing a programme of research education for the early-career researcher or doctoral student interested in bridging the perceived disciplinary divisions? How might individual educators, and perhaps more pertinently their academic institutions, provide a toolkit and language for mutual discovery and ideas? What changes to university structures and traditions need to be made in order to encourage and foster a dynamic transdisciplinary research culture?

5.2 The Current Scenario: Difficulties and Imperatives

Successful transdisciplinary research activity requires an acknowledgement of the need to challenge and restructure traditional hierarchies of knowledge, a willingness to be open to ideas and methods from other disciplinary areas, a genuine desire to add value to a collaborative venture that includes communication and reflection, and an ability to work with a degree of ambiguity. However, many see the current dominant regime of the management of UK university economics and structures as 'discouraging risk taking' (Ingold, 2011; Pollock, 2008; Rowland, 2006: 100), concerned as it is with today's climate of a conservative audit culture, where methods of evaluating and measuring success are primarily disciplinary based. This culture and climate can work particularly against early-career researchers and doctoral students, whose natural tendency for innovative experiment is constrained to a 'play safe' strategy.

Certainly, the difficulties that can be encountered in trying to conduct research that crosses institutional or disciplinary boundaries are increasingly noted in academic communities across the world. Reports in both the USA and the UK have highlighted many factors in institutions acting as strong disincentives for junior researchers pursuing scholarly work that crosses boundaries (Boden, Borrego, & Newsander, 2011; Thew, 2007). Lack of sufficiently knowledgeable referees, organisational barriers and fears of reduced career promotion opportunities were among the concerns cited.

Undoubtedly, the increasing risk-averse climate further embeds this pressure to pledge exclusive alliance to one's core discipline, as faculties and departments bid

competitively for internal funding, support and recognition. Within this competitive environment and its relative intolerance of uncertainty, to have the confidence to step outside one's usual field, to be prepared for dialogue with others who may not share your specialist language and metaphors, and to have the intellectual humility to express the limitations of one's understanding of particular perspectives are not undertaken lightly – especially if you are under managerial pressure to produce quick, publishable results that will count in a Research Excellence exercise. Yet, surely, it is important for those of us teaching and nurturing the next generation of academics, researchers and practitioners to raise their awareness of the truly unpredictable and ambiguous nature of research, rather than to simply counsel meek compliance with a conservative tick-box audit culture?

As society itself becomes increasingly complex, it is important for academic institutions to shed the presumption that learning can always be reduced to the predictable and the easily measurable. Yet, too often, senior academics in particular can display opposition or rejection of other disciplinary perspectives in heated defence of their own territory – a response which often masks the worry that we all have over the difficulty of learning new material, languages, metaphors and methods – especially if some of these come from outside of the academy.

Nevertheless, several authors (Forty et al., 2006; Dunin-Woyseth, 2012) have asserted that transdisciplinary research should 'transcend' traditional sovereignties of knowledge, and needs to build in the capacity to consider the know-how of professionals and lay people on equal terms. Nowotny (2003: 2) reminds us that 'Knowledge is Transgressive and transdisciplinarity does not respect institutional boundaries'. In the area of healthcare, for example, Platten and Biggs (2014: 130) suggest that 'the normal advocacy undertaken by charities, patients and their carers can do little in the face of powerful professional orthodoxies, framings and asymmetrical power structures'. Similarly, in 2013, one of the Action Clusters suggested by the US-coordinated Science/Engineering/Art/Design (SEAD)[1] Network White Papers highlighted the importance of 'grass roots' innovation and the inclusion of local communities in participatory events designed to look at solutions to global and local challenges. Equally important is the identification of culturally appropriate applications of emergent technologies and the recognition of the ethical issues that can arise. SEAD papers suggest the need for 'citizen-science' initiatives through such activities as art and design competitions, community think-tanks and the like, in order to encourage and support co-creative transdisciplinary work (Barnes & Castellanos, 2012; Kera & Dusseiller, 2012). One could argue that only when academics and their institutions more readily engage with the open-ended nature of true transdisciplinary dialogue and recognise the potential benefits of such

[1] SEAD is the Science, Engineering, Art and Design Network, coordinated in the US and operating internationally. Recognised and supported by the US National Science Foundation, in 2013 the Network called for position papers to set out primary conditions for the furtherance of education and training in SEAD subject clusters, alongside philosophical considerations pertaining to the successful application of transdisciplinary approaches to global issues of concern. The final White Papers are posted at http://seadnetwork.wordpress.com/white-paper-abstracts/final-white-papers/

conversation in tackling 'real-world' problems in partnership with the wider community can we begin to really claim meaningful 'research impact'.

This dichotomy also comes into play when the forms of publication, exhibition and dissemination of the outcomes of transdisciplinary work are considered. Operating at the edges and intersections of disciplinary traditions means it is often difficult to find peer reviewers who are willing to critique such work with an open mind, and the more esteemed journals and conferences can be unwilling to include papers that fall outside of their mainstream experience. Similarly, many ArtScience[2] projects result in creative artefacts that present new challenges for traditional galleries, curators and commentators due to their rejection of the notion of the passive observer and the invitation to audiences to become active participants in the work presented. Undoubtedly, both a reassessment of classical scholarship and publication categories is required (Kueffer, Hadorn, Bammer, Kerkhoff, & Pohl, 2007), alongside a more imaginative approach to funding guidelines for exhibiting and curating art-science collaborations (Devčić, 2014).

5.3 An ArtScience Transdisciplinary Agenda: The 'Project Dialogue' Approach to Pedagogy

The founder members of the transdisciplinary ArtScience group 'Project Dialogue'[3] – Barbara Hawkins, Brett Wilson, Stuart Sim and Iain Biggs – have been academics for many years. Our relationship as collaborators has matured over several decades, during which time we have probably listened to, assimilated and responded to each other's arguments, criticisms and conceptual models with much closer attention than is usual between practitioners in art education, science and philosophy. Developing an appreciation of how other disciplines go about their 'ways of knowing' has certainly brought into sharper focus for each of us the knowledge values and embedded metaphors associated with our own respective research communities. As collaborators, we have sought to explore the fundamental elements

[2] The term 'ArtScience' has become the contemporary phrase to describe research practice and collaboration which encompasses the interests and expertise of the arts and the sciences. Promoted by the long-established journal *Leonardo,* the ArtScience agenda has now expanded to create productive and stimulating opportunities for networks of scientists, artists and cultural commentators beyond the more restrictive boundaries of earlier 'Sci-Art' or 'Art & Science' funding regimes.

[3] Project Dialogue (www.projectdialogue.org.uk) was established in 2006 in the former Department of Art & Design at the University of the West of England, while the author was Head of the Postgraduate School. The co-founders have since taken semi-retirement from their full-time academic posts, but continue to work as independent educational consultants developing new postgraduate teaching strategies and to publish transdisciplinary papers across the fields of art and science, alongside coordinating Project Dialogue. Recent papers cover a variety of topics from the role of metaphor in science, through artistic approaches to ecosophy to the practice of ArtScience research. In 2014 our book, *Art, Science and Cultural Understanding,* was published by Common Ground, and includes chapters from a number of Project Dialogue colleagues across a range of discipline backgrounds and artistic practices.

that constitute effective and novel research with a view to achieving a more permeable relationship between traditional academic boundaries. Our objective has been to promote a transdisciplinary ArtScience forum for enquiry into the arts and sciences, so as to encourage a broader examination of their practices and research methodologies by interrogating their fundamental conceptual models, structures and metaphors.

Viewing the foundational assumptions and ideological baggage of one's own field through the eyes of practitioners from other disciplines helps to reveal underlying commonalities in research processes and broadens our perception of the nature of research. The analytical auto-ethnographic approach developed by Anderson (2006) can be a useful methodology in this respect. Features of the method – analytical reflexivity, narrative visibility of the researcher's self, dialogue with informants beyond the self and a commitment to theoretical analysis – all promise valuable tools for the development of insights into how a creative relationship between art and science research practice could evolve into an even more fruitful knowledge paradigm.

Since founding the research group, we have developed a number of different ways of working – from holding medium-sized transdisciplinary symposia, through working with small research teams from other groups and centres on specific problem areas, to formal and informal seminars and workshops with doctoral students and postgraduate cohorts. The flexible nature of the group's associate membership has enabled different combinations of collaborative endeavour resulting in journal and conference papers, a multi-authored book and a variety of arts practice exhibitions. It could be argued that, as each of the founder members has reached the closing stages of our long and productive academic careers, then we have the relative luxury of being able to take risks, to be provocative and to venture into new territory without fear of approbation. However, the many positive responses to our seminar and conference contributions and the growth of membership of Project Dialogue have encouraged us to believe that increasing numbers of early-career researchers are equally keen on developing transdisciplinary insights and approaches in their work (especially as this response has been from early-career researchers themselves).

An early Project Dialogue intervention was a series of fortnightly workshops and seminars within our own department as an experimental teaching activity shared between myself as the (then) head of the graduate school in a school of art and design, and semi-retired scientist Brett Wilson as 'scientist in residence'. Many of our doctoral and Masters students at the time were echoing our own view that some of the most interesting research was happening at the interface of art and science and that, to be part of this broader movement, they felt that they needed an expanded lexicon and new methodologies with which to operate. Our aim was to introduce arts practice research students to imaginative conceptual models, offer opportunities for collaborative understanding and to create a community of mutual cross-disciplinary interest and enquiry. Participants included fine artists, printmakers, graphic designers, glass and ceramic artists, and other craft practitioners alongside academic researchers from the physical, natural and neurological sciences. Students

were offered opportunities to investigate strategies by which they might better understand scientific principles, histories and conventions, in order to engage in an arts–science practice with greater creative confidence and insight. We also introduced our own deeply held view that both art and science employ many shared forms of critical thinking, creativity and imagination in order to try to understand the world, and we wanted to help students to recognise the common craft skills of research that bind the general community of practice of research more closely than they might think.

Following the workshops, many students began to see their roles as practitioners directly engaged in research as a stronger identity than the narrower traditions of their own individual fields of practice. It became clear to us during these early sessions that developing transdisciplinary teaching approaches not only benefits students, by offering a broader educational experience, but also helps to overturn staff misconceptions, by inviting them to work closely with other practitioners from dissimilar backgrounds. Working subsequently with a range of student cohorts and teaching staff in other settings, we have certainly witnessed a new language of discourse entering into debates when these notions are appropriated by the studio and seminar room.

5.4 Examples of ArtScience Transdisciplinarity in Action

In our book editorial introduction (Wilson, Hawkins, & Sim, 2014), we have noted that the appropriation of scientific concepts by philosophers, artists and cultural theorists is often criticised for being imprecise, when it could more profitably be viewed as an attempt to use those concepts in a figurative way that makes us rethink our assumptions about reality, generating interesting new questions in the process. Wilson and Sim (2015) suggest that metaphors should now also be regarded as central agents in developing new conceptual models in the sciences as well as the arts, further highlighting the commonality of creative thought and that the arts, humanities and sciences should not be viewed as separate intellectual realms based on immiscible modes of thinking. Accepting that science also is built on both figurative and literal modes of understanding opens the door for a genuine aesthetic of ArtScience to emerge.

The gradual and sometimes grudging acceptance of the arts practice-led doctorate in the UK and elsewhere over the last decade has played a role in shifting the manner in which critical enquiry in all fields is evaluated through contemporary academic procedures. The culture of art practice research might validly claim to be less constrained than the sciences by conventional research methodologies, and far more likely to draw on multiple disciplinary traditions. Arts practitioner–researchers often use methods borrowed from the social sciences, humanities and physical sciences to find an epistemological framework for their argument. This transdisciplinary boundary-crossing in search of appropriate theoretical discourse transcends

simplistic notions of knowledge transfer in favour of genuine hybrid forms of knowledge and understanding.

The broader remit of ArtScience, as developed by some of our artist colleagues in Project Dialogue, results in visceral artworks that pose cultural, ethical and ontological questions, some of which can be extremely challenging and engage audiences in rich and complex ways. The point of departure for ArtScience is that the artists are themselves creating new research partnerships with scientific communities, rather than simply reflecting science-inspired motifs in their work. In the collaborative process that ensues, new ways can emerge of considering global problems such as climate change, food provision, land use and healthcare for a rapidly expanding world population. Viewing the bio- and neuro- inspired work of practitioners such as Helen Pynor or Susan Aldworth, for example, raises fundamental questions of what it might mean to be human in the twenty-first century, while artefacts created by Luke Jerram and Shelley James have changed the vocabulary and working practices of virologists and ophthalmic nurses (Hawkins, Jerram, & James, 2014).

It is encouraging to note that, in the UK, there has been an increase in the number of university and museum residency schemes that fund and support arts practitioners to work across academic disciplines such as neuroscience, bioscience, entomology and botany, engineering and colour science. However, while the 'artist in residence' is now fairly commonplace, there's been no complementary rise in the number of 'scientist in residence' schemes of the type introduced by Project Dialogue – a move which could further enhance a transdisciplinary mode of thinking in doctoral training programmes.

Transdisciplinary study can bring with it an enrichment of creativity, novelty and originality, with an enormous satisfaction to be gained from the potential to create new types of knowledge and understanding through deep and insightful collaboration of disciplines. In earlier papers, we have argued that all good research should challenge the underpinnings of our conceptual models (Wilson, Hawkins, & Sim, 2013), and certainly the challenge that arises from looking at something from a new extra-disciplinary point of view is that it transforms our experience of the world. Significant research value comes from the changes that occur when we shift from one form of description or analysis to another. The benefits to society of supporting a new generation of researchers who are capable of and enthusiastic about the prospect of examining many of today's complex issues through a collaboration of methodologies, expertise and knowledge bases cannot be underestimated. Education should help to prepare us as individuals, cultural agents and societies for a future that will always be to some extent unknown – no matter how hard particular government-inspired policies may seek to engineer specific ends. Yet modern curricula in the overwhelming number of higher educational courses are far too narrow to give participants (either students or staff) sufficient breathing space to explore beyond fairly rigid and conventionally-determined boundaries.

Postgraduate students and early-career researchers, with their enthusiasm and curiosity to find novelty, are perhaps less hidebound by expected disciplinary traditions, and are certainly capable of developing significant innovation in their

endeavours. However, too often they can be intimidated by the obstacles that they face when challenging the largely discipline-specific environment in which they study and work. During a period of increased interest in the crossover between arts, humanities and physical and natural sciences, preparing students for transdisciplinary research projects must become an integral part of doctoral education. This ambition, however, implies challenges for both individual academics and the institutions within which they work.

5.5 Institutional Challenges and Suggested Courses of Action

Infrastructural encouragement of and support for curriculum and research developments that nurture transdisciplinary talent and expertise are vital for a successful transformation of the way in which we traditionally view disciplinary domains and boundaries. Several academics have justifiable concerns about what difficulties can arise as members of different disciplines attempt to collaborate: the acceptance of the commonalities which underpin all research, and which can facilitate the translation of understanding across disciplines, can also lead to a deceptively simplistic view of other disciplines and the complications of working together. It is important, therefore, that institutions offer the time and create the opportunities that researchers need to come to terms with the methodological subtleties of their potential transdisciplinary partners' domains.

In particular, the provision of physical and virtual spaces in which staff and students can build communities of interest and enquiry would help to foster a spirit of communication and networks both internal and external to the institution. Within this space, training opportunities need to be designed and launched for postgraduate students to hone the necessary skills and confidence to communicate theory and practice across disciplinary domains, thus improving their intellectual development, creativity and employment potential.

Equally, vice-chancellors need the incentive to advise departmental, faculty and research group heads to recognise and reward the activity of staff whose research transcends traditional disciplinary boundaries, so offering a sense of potential career development and providing role models for future early-career researchers and doctoral students. The allocation of internal research funds and the annual appraisal of junior research staff might then be more likely to evaluate potential transdisciplinary proposals or completed research projects with a more all-encompassing lens.

While academic promotion and tenure continue to be governed by a research publication record in high-impact, peer-reviewed, discipline-based journals, transdisciplinary practitioners can be disadvantaged by the current paucity of high-quality publication outlets for their work. Scholarly and professional societies that have played key roles in the development of digital restructuring of forms of publishing, documenting and curating original works and the scholarship surrounding

them have, to date, been largely ignored by most university institutions. Resolving some of these issues will require the kind of thinking put forward by Davidson and Goldberg in their report, *The Future of Learning Institutions in the Digital Age* (Davidson & Goldberg, 2009).

Concurrently, institutions need to create project grants, scholarships, fellowships and bursaries for students and staff working in transdisciplinary modes and actively encourage the recruitment of applicants submitting transdisciplinary doctoral proposals. Reduced teaching loads, residency programmes for visiting academics, invitations for the participation of individuals from the community or non-profit organisations could also encourage transdisciplinary collaborations.

Such moves to create and support collaborative research ventures need not necessarily lead to a merge of disciplines, or the wholesale destruction of traditional disciplinary methods and histories, but rather would create agile and imaginative cross-connections among like-minded researchers and practitioners. Nurturing the potential links of deep disciplinary research could both mine the rich resources already embedded within them and, at the same time, reinvest them with greater relevance for non-specialist colleagues in other fields. For postgraduate students, this introduction into a wider community of the practice of research could then include courses that examine and compare the methodologies and tools employed by artists, scientists and those from the humanities that foster understanding of the processes and outcomes across disciplines. Such a curriculum would promote a student-centred model of pedagogy that redefines transdisciplinary lecturing staff and doctoral supervisors as facilitators, collaborators and co-creators of knowledge.

Just as fundamental to the introduction of such moves is the need for a cultural change among members of the academic community itself. Supporting students in a transdisciplinary research environment requires a degree of academic humility and self-reflection, and possibly a willingness to forgo the personal power-base often associated with traditional monodisciplinary hierarchical structures. For a PhD supervisor, for example, this may mean relinquishing the role of individually mentoring a research student in the tried and tested methodologies and bibliographies of their own discipline, instead collaborating with co-supervisors to provide different disciplinary insights and complementary expertise. At the taught postgraduate course level, the shift in thinking involves a willingness to allow into the curriculum alternative views, academic discourses and modes of thinking that may occasionally challenge the discipline-specific contexts of teaching and learning that a course leader would normally include.

Naturally, not all academic staff would be willing (or able) to make such changes to their ways of thinking and working. The most effective route forward for a university would be the creation of an institution-wide transdisciplinary research centre, with a remit to nurture, support and encourage emerging scholarship and practice in this area. Such a centre could be comprised of a small number of full-time staff, but with sufficient budget allocation to 'buy in' academics from different departments to offer mentoring, seminar programmes and supervision, and also to

offer advertised bursaries to prospective doctoral students submitting proposals of a transdisciplinary nature.

The centre could provide:

- Training programmes for early-career researchers interested in developing a research profile that includes transdisciplinary projects
- A meeting place (with both structured and informal opportunities) for like-minded academics to discuss potential collaborations and share insights into their disciplinary foundations
- Training for doctoral supervisors to build the skills and sensitivities needed to co-supervise transdisciplinary research projects
- Space for non-academic members of local communities to debate and discuss potential solutions to local and global issues alongside academic researchers
- The creation of a data-base of digital peer-reviewed publishing outlets for scholarly work and transdisciplinary practice
- A comprehensive postgraduate curriculum designed to enhance transdisciplinary understanding and methodology.

This curriculum might include:

- Short residential weekend or summer schools, bringing together groups of cross-disciplinary doctoral students to work together on a 'teams and themes' approach to suggested topic areas of investigation
- Modules delivered by staff from departments in the sciences, arts and humanities designed to explore a 'history of ideas' from multiple perspectives
- Seminars designed to build confidence in presenting ideas to non-specialist audiences and potential employers
- Guest lectures from active transdisciplinary practitioners, discussing their methods and approaches
- Workshops designed to explore the nature of public engagement, social entrepreneurship and commercial opportunities for the outcomes of transdisciplinary projects.

Benefits to be derived from transdisciplinary research centres of this nature are numerous. Such initiatives would provide much-needed encouragement and an environment within which emerging transdisciplinary scholars could flourish and communicate their findings, without fear of career stagnation, alongside appropriate support for the new generation of doctoral candidates. A difficulty often encountered by postgraduates wishing to work across disciplines is that of finding supervisors who are themselves able to adopt a much broader research perspective than is usually the case. Even more problematic is the process of inviting a sympathetic examining panel open to assessing the work without disciplinary prejudice. A centre which involves academic staff from across the institution's departmental base would offer opportunities for more established, discipline-focused academics to explore the potential of new ways of operating in a spirit of open and dynamic intellectual experimentation – a process which Rowland (2006: 96) suggests has significant value in helping us to understand what it means to be an artist, geographer, doctor

or engineer, and actually strengthens our professional identity. Over time, the centres would be able to build a rich pool of senior academics, better equipped to supervise, support and examine the outcomes and findings of transdisciplinary research students. Since these academics are also likely to be those frequently called upon to peer-review research proposals or journal papers, then a publication culture for transdisciplinary work might become more firmly established, as editors and reviewers begin to take a broader view of what constitutes valid and publishable research related to their disciplinary area.

Institutionally, a broad and inclusive site for fundamental debate and activity would provide a distinctive, auditable base for a range of transdisciplinary research outcomes, such as team-based scholarly publications, software tools, ArtScience works and partnerships with industrial and community ventures. Transdisciplinary research, by its very nature, opens up a number of exciting and stimulating motivations for researchers from any disciplinary area, with valuable opportunities for collaborative enterprise and knowledge transfer activities which offer wider commercial or cultural outlets for the outcomes of the enquiry. An openness to inter-disciplinarity and a keen interest in collaboration are qualities that are increasingly sought in new recruits by industry executives (Connor, Forbes, & Docherty, 2010), while the UK research training organisation Vitae frequently cites the ability to collaborate across disciplinary teams as a key factor in improving student employability potential. Under the framework of its outreach activities, a transdisciplinary research centre could most usefully establish a network of industrial partners willing to host research placement opportunities that explore novel approaches to problem solving.

An early definition of transdisciplinarity described it as 'a new form of learning and problem-solving involving cooperation among different parts of society and academia in order to meet complex challenges of society…. Solutions are devised in collaboration with multiple stakeholders.' (Klein et al., 2001: 7). For our future generation of research academics to become sufficiently fluid and mobile to play a meaningful role in seeking these solutions to complex problems, institutions must evolve new ways of training and mentoring postgraduate students to have the confidence to communicate theory and practice across disciplinary domains. Centres of the type described above represent a very promising approach to providing an intellectually and financially fruitful route through an increasingly complicated research landscape.

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Chapter 6
Transdisciplinary Content Pedagogy in Undergraduate Engineering Education: Being Pulled Up Short

H. Greenhalgh-Spencer, K. Frias, and A. Ertas

6.1 Introduction

Transdisciplinary education offers an opportunity to enhance complex problem-solving skills for engineers (among other disciplines), increase efficacy for diverse students and increase possibilities for deep learning experiences. To borrow a phrase from Gadamer, Weinsheimer, and Marshall (1975/2004), transdisciplinary education creates moments where students and teachers are 'pulled up short'. To be 'pulled up short' constitutes a moment where a person suddenly sees things differently, they become aware that what they thought was wrong, misguided or not a full understanding, and they become more open to learning. The moment of being 'pulled up short' is often the aim of many educational interventions. This paper argues that the curriculum and pedagogy – the content pedagogy – of transdisciplinary education fosters such moments.

In order to test the efficacy of transdisciplinary (TD) content pedagogy, we undertook a quasi-experimental case study design research project where we compared the levels of engagement, trust, collaboration and problem-solving skills developed in an undergraduate mechanical engineering course and compared those results with a 'control' mechanical engineering course that was on the same subject matter. As such, this paper identifies the literature relevant to TD with an emphasis on the gains in problem-solving skills and increased efficacy for diverse students in an effort to identify a gap in our current knowledge associated with TD in practice. To test the practical implications of this approach, we utilised an experimental field-study of undergraduate mechanical engineering students enrolled on a senior engineering design course. Findings suggest that the TD course does increase collaboration, problem-solving and engagement. Our results also show that TD con-

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tent pedagogy allows students to engage in rich learning experiences that create moments where they see the world differently, where they are pulled up short; and this approach may give students important advantages in the classroom and the workforce.

This paper explores the benefits of TD content pedagogy by first examining the literature on TD; in these sections, we define TD in a general sense, and then move further to define TD curriculum, TD pedagogy and TD content pedagogy. We then describe the classroom environment in which the TD mechanical engineering course took place which, we hope, offers more concrete examples of TD content pedagogy in the classroom. We then define the methods of the study that allowed us to examine the efficacy of TD content pedagogy. We briefly analyse our findings on the benefits of TD content pedagogy for problem solving and for engaging underrepresented students, although these findings are explored in more depth in other publications. We then turn to an explanation of what it means to be 'pulled up short,' why this is important for teaching and learning, and then explore how the TD mechanical engineering course was able to provide moments of being pulled up short for the undergraduate students. We conclude with some of the implications of this study.

6.2 Literature on TD

Transdisciplinarity is often defined as the transgression of boundaries among and between fields. It is the use of an array of paradigms, methods and knowledge from various fields with the primary goal of solving complex problems with social well-being applications. It is an awareness that real-world problems often occur at the intersection of multiple fields of expertise and that knowledge fields are interdependent upon each other in order to solve these complex problems. TD relies on a holistic approach to knowledge, research, practices and paradigms.

Transdisciplinary (TD) has been described with myriad meanings or in many different ways. TD can have epistemological claims; that transdisciplinary knowledge is a new form of knowledge (Brylina, Kornienko, & Kabanova, 2014; Grice, 2014). TD can be a method for understanding problems or questions (Nicolescu, 2014). It can be a research methodology that brings multiple fields of knowledge and practice together (Ertas, Frias, Greenhalgh-Spencer, & Back, 2015; Lang et al., 2012). TD can be used to describe a curriculum (Bostan, 2015; Dieleman & Juárez-Nájera, 2015). TD can also be used to describe a pedagogy where it is not just the curriculum that brings multiple fields of knowledge and practice together, but that the method of teaching – the teaching and assessment strategies – aims at creating opportunities to use practices from multiple disciplines (Gilliland & Halilovich, 2016; Rahul et al., 2015). This paper extends the current literature on TD by providing concrete examples of the efficacy of TD education as compared to a 'control' group. The TD classroom in our study used both TD curriculum and TD pedagogy. Therefore, it is important to parse some of the differences of TD curriculum and TD pedagogy.

6.3 TD Curriculum

While the TD curriculum is typically used in conjunction with TD pedagogy, it is relevant to separate the two in order to analyse better whether and how each contributes to a classroom experience individually before we make propositions about their combined contribution. The TD curriculum takes a view of knowledge that, rather than being arboreal or hierarchical – where one knowledge set is more important than or takes precedence over another knowledge set – knowledge is more rhizomatic – where knowledge is seen as interconnected and interdependent. The TD curriculum takes as its beginning a problem to be solved or a project to be developed, and then shows how knowledge from multiple disciplines must be brought to bear in order to solve a problem. This is in contrast to multidisciplinary or interdisciplinary curriculum projects, which are underpinned by the desire to teach a specific field of knowledge and then show how other fields of knowledge can be meaningful for or additive to the foregrounded field of knowledge.

David Moss (2013), a curriculum theorist for curricula in law schools, notes that the TD curriculum focuses more on allowing students to understand knowledge in a holistic way rather than an additive way. 'Knowledge is, by its very nature, transdisciplinary; to artificially, and often arbitrarily, carve it up will assuredly present certain difficulties in the context of formal programs of study' (Moss, 2013: 26). Moss (2013) argues, 'when we build a programme solely around the individual parts, we invite challenges upon the novice learner attempting to see the bigger picture. A transdisciplinary perspective is fundamentally different than multidisciplinary or even interdisciplinary perspectives in that it starts with the consideration of the "whole"' (p. 26). The TD curriculum involves 'a pivotal move away from the individual parts toward a multifaceted whole' (Moss, 2013: 26). It involves a particular view of knowledge as a sequence of interdependent concepts, skills and potential solutions. Unlike inter- or multidisciplinary studies that often begin with terminology or series of topics, the TD curriculum originates with a problem. That problem is then addressed through the TD curriculum which is adapted in real time to solve the proposed focal problem. This is related to, but different from, TD pedagogy.

6.4 TD Pedagogy

TD pedagogy is about the *way* of learning a curriculum. As Monk, Rutter, Neelands, & Heron argue (2011), TD pedagogy involves 'creating conditions in which learning is immediate, enactive, and alive' (p. 1). Monk et al. (2011) further argue that TD pedagogy involves a learning experience where students get up and move together in order to facilitate collaboration and interaction. It is a pedagogy that rejects the idea of 'the tutor at the head of the room facing the seated, subordinate class' (Monk et al., 2011: 4). Derry and Fischer (2010) contend that TD pedagogy involves creating opportunities for students to understand and develop distributed

intelligence and collective intelligence. That is to say, students need to be given opportunities to understand where their own knowledge sits in relationship to other knowledge, and how those different knowledge sets can come together to solve a problem. In order for this to happen, there must be multiple opportunities for students to collaborate; and not just collaborate, but to collaborate with people who have very different experiences and knowledges. For example, TD pedagogy would advocate for boundary-less classrooms in which outside collaboration such as industry experts could engage, evaluate and contribute to classroom activities. TD pedagogy involves using tools, project-based learning or thought experiments that are designed to show the ways that knowledge fields, while distinct, must be brought together in a holistic way in order to solve problems. While the TD curriculum insists that knowledge fields are parts of a larger whole, TD pedagogy develops ways for those fields to come together as a whole toward solving complex problems.

6.5 The Intersection of the TD Curriculum and TD Pedagogy: TD Content Pedagogy

In this paper, we focus on the intersection of the TD curriculum and TD pedagogy. Curriculum is different from pedagogy. Curriculum refers to the content used in a course, the concepts taught, and the knowledge objectives. Curriculum gets at the idea of *what* is to be learned. Pedagogy, on the other hand, focuses on *how* learning is to happen. Pedagogy involves teaching strategies and tactics. Theories of *how* students learn are translated into best practices of *how* to teach. While curriculum and pedagogy are distinct, there are times when the two come together to form a specific approach to learning. For example, in the TD-based course that we studied, the instructor used both a TD curriculum and TD pedagogies. When a specific curriculum works best with a specific type of pedagogy – when the two become interdependent on each other – a new term is often used to describe this symbiotic relationship between curriculum (content) and pedagogy: content pedagogy. Our methodological design required that we test our propositions using TD content pedagogy, and it is TD content pedagogy that, based on our study, we find, can specifically lead to increased readiness for the workforce, increased engagement by underrepresented students and, finally, increased opportunities for learning moments of being 'pulled up short'.

TD content pedagogy may – and likely should – look different, depending on the objectives and students in a course. For the undergraduate mechanical engineering (ME) course used for our study, the content pedagogy was aimed at both ME design skills and the development of skills, mindsets and knowledge to solve real-world problems. Content around ME design principles was discussed and developed using multiple pedagogical strategies. Furthermore, content around environmental concerns, social justice issues, marketing and other knowledge domains was also

important for the course, and this content was often delivered by knowledge domain experts in the form of online conversations, podcasts and mini-lessons. The content aimed to provide the students with deep learning in ME, but also with the content that they would need from other domains in order to make informed designed choices for real-world problems that often rely on multiple knowledge domains.

For this course, there were also several pedagogical strategies that came into play. The instructor used technology-embedded learning, which involves the use of online chat and communication platforms in order to learn together, communicate together and discuss topics with knowledge domain experts who would not normally be part of an ME course. Discussions with knowledge domain experts were important to generating the needed knowledge for the ME students to work on some of the complex problems; and in fact, the inclusion of domain experts from outside the field of ME was a teaching strategy deployed by the instructor. The instructor also used visualisation tools better to help the students plan and organise their ideas for specific problems (more will be said about this in the next section). The instructor used Interpretive Structural Modeling and other visualisation tools to help the students to model potential solutions and understand how knowledge fields fit together.

Additional pedagogical strategies used in this course included more student-centred approaches to teaching. In fact, the instructor described to the researchers and to his students his commitment to:

- facilitation, not didacticism
- multiple apprenticeship opportunities
- project-based learning
- group work stations
- ubiquitous learning
- ubiquitous collaboration.

This commitment to pedagogical strategies that would promote collaboration and co-creation of knowledge and problem solving was evident even in the way that the classroom environment was set up. Rather than having chairs and desks in single-file rows, the instructor had students sit at tables. He gave them time in class, and then also made available an online platform so that students could meet out of class to work on their projects. The instructor and students provided food for all to share, and this encouraged a relaxed atmosphere in the classroom. There were certain times when the class officially met when students had to be in class, but there were other days when the students were encouraged to find a more relaxed place to meet with their project groups and either go over plans or participate in discussions with domain experts online. Students had to show that they were making progress toward the end project goal of solving a specific real-world transportation problem, but they were also given much more leeway in how to attend the class than is traditional on undergraduate engineering courses.

The TD content pedagogy was focused on: identifying social issues and/or societal problems; creating a collaborative research team and a collective understanding of the problem; developing collective intelligence through collaborative research to

solve the societal problem in question; analysing the problem through a method of problem decomposition; and knowledge creation and integration in order to solve the specific real-world transportation problem. The next section provides a more fleshed out description of TD content pedagogy in the TD course that we studied.

6.6 TD Study: Description of the TD Mechanical Engineering Course

The TD ME course was focused on showing students how to use their ME skills and knowledge to address real-world problems. Most ME design courses involve students working on projects where they have to apply the knowledge and skills they have learned in other ME courses. The TD version of this course focused on applying ME knowledge to design a solution to a problem with real social consequences. Students were encouraged to think about projects that they could tackle that would have real impact on people. Thus, rather than a course that simply focused on applying ME knowledge to any engineering problem, the TD version of the course specifically guided students to think about problems that have a high impact on large groups of people or a whole society.

As part of their initial work for the course, the students came up with four main engineering problems to solve with direct consequences for society. The TD ME students wanted to design:

1. An eco-railway (high speed train system design) that would unite two urban hubs
2. A system that would use tidal power to generate clean energy
3. A system that would clean and store water in order to impact the water crisis in the western US
4. A system that would better monitor local weather to help warn people in case of severe weather.

In order to tackle a problem better, the instructor insisted that the class coalesce around one of these problems, and then parse out that problem into sub-issues with different and multiple knowledge and skill domains.

The class voted on which project they would address as a class, and the class chose the eco-railway. This TD course took place at a university in Texas, so the students decided to design an eco-railway that would connect Dallas and Houston. This not only provided the students with a local connection, but the students were aware that Dallas and Houston are two of the largest cities in the US, so designing an environmentally conscious high-speed rail to unite these two cities would have a great impact on a large number of people.

The eco-railway project was then decomposed into four main sub-fields of knowledge; the class was then divided so that there were an equal number of people working on these four sub-fields:

1. Economic modelling group
2. Mechanical design group
3. Electrical systems design group
4. Social issues group.

The groups were not considered to be independent of each other. Just as complex problem-solving relies on the interdependence of multiple knowledge fields, these groups were aware that they would have to work together and learn from all of the different groups in order to enable good decisions by each of the different sub-groups. For example, while one group was specifically tasked with thinking about how the cost of the eco-railway would affect the marketability the railway, as well as determine the relative socio-economic status (SES) of the passenger who could afford to use the railway, this group – the economic modelling group – provided feedback on their research that influenced the design decisions of both the mechanical and electrical systems groups. In order to make the railway affordable for all citizens, including low-socioeconomic status (SES) citizens, design decisions were made to use cheaper materials that would still allow the railway to run safely. The social issues group gathered information about both environmental patterns and housing patterns. This influenced the decision of where to run the eco-railway. Students wanted to make sure that the railway was: leaving as minimal an environmental footprint as possible; creating an impact on commuters who might have used other means of transportation to get between these large urban cities; and located in an area where people with low SES would have easy access to the train.

In order to help the students to visualise the complex interactions of all of the different sub-groups, computer-aided visualisation modelling tools were used. According to students, the most significant visualisation tool was Interpretive Structural Modeling (ISM). ISM was used to help the students theorise the interdependencies of factors affecting the design of the high speed train. It is a computer-assisted learning process that provides a fundamental understanding of how various parameters (elements, variables, system components, etc.) relevant to the problem or issue are interrelated and thus helps researchers to structure them in a meaningful manner to develop collective intelligence to overcome challenging complex problems.

ISM and multiple other computer-aided visualisation tools helped the students to create a collective understanding of the problem. This collaborative co-creation of knowledge was facilitated by the diverse backgrounds of the students and the development of distinct knowledge bases. These groups did research on their particular area, and relied on conversations with domain experts grasp to more fully the knowledge needed for their sub-group and how that knowledge would feed into the creation of the eco-railway. This co-creation of knowledge not only provided skills that will be valuable in the workplace, but also provided fertile ground for some of the ‘pulled up short’ moments of the class.

The next section describes the research methods used for this study on the efficacy of TD content pedagogy.

6.7 TD Study: Methods

In order to understand better the interventions, benefits and challenges of TD content pedagogy, we conducted a quasi-experimental study on TD content pedagogy applied to an undergraduate ME course. We wanted to compare what was happening in the TD course with what would happen in a traditionally-taught version of the same course. Our experimental design consisted of targeting two undergraduate ME design courses taught to seniors. Both courses were taught by the same professor and his graduate student. This professor had used TD content pedagogy in graduate courses – and indeed, has published articles on TD research methods – but had not taught undergraduate courses using TD methods. He agreed to teach one of the ME design courses using TD content pedagogy and the other ME design course in the way that he had been teaching that same course in the past. This course was a year-long course, so we were able to see the results of TD content pedagogy over the course of both the Fall and Spring semesters.

We developed a test designed to gauge levels of engagement, levels of collaboration, creativity and other 'soft' skills. We also developed interview questions designed to elicit feedback from students about their experience in the course, their levels of engagement and the types of skills that they felt that they had gained over the year of the course. After obtaining approval from the university's institutional review board (IRB) for this study, the 'stimulus' test and the interview questions, we gave the test as a pre-test to the 38 students in both ME classes (17 students in the experiment section and 19 students in the control section). This same test was given as a post-test at the end of Fall semester in order to evaluate any gains in engagement, collaboration and other skills. The tests were taken anonymously. However, demographic information was solicited in the test. This demographic information included gender, race, ethnicity, social class, nationality and first language. At the end of Spring semester, interviews were conducted with willing class members; these interviews focused on developing a conversation with the student about the benefits, challenges and unique moments of the course.

Students were unaware of the nature of the TD design study when they registered for the courses and were not allowed to switch sections after they registered. Both the experimental section and the control section included all male students. In the experimental section, there were 70.5% white males and 29.5% males of colour. In the control section there were 74% white males and 26% males of colour. All the students in both sections were senior ME students. An independent sample t-test indicated that, upon entering the design course, grade point average of students in both experiment and control groups did not have significant statistical difference in grade point averages at the 95% (two-sided) level of confidence in two means of grade point average of two sections.

The sources of data for this study consisted of the pre-test and post-test given to both the TD ME course and the control ME course, and classroom observations and in-depth interviews of willing students in the TD course. All of the data collection techniques were accomplished using IRB-approved methods. An audit trail was

kept to increase reliability and trustworthiness. Data were analysed using cross-comparative methods for the pre-tests and post-tests. The interviews were analysed using open and thematic coding (Marshall & Rossman, 2014; Saldaña, 2015), and the constant-comparative method (Fram, 2013; Kolb, 2012) was used in order to categorise emerging themes from the interviews. As part of the pre/post-test, demographic information was collected. This enabled us to analyse the results of the pre/post-test using race and other identity markers as categories of analysis.

The study revealed that there was an increase in students' trust, creativity and collaboration skills from the beginning of Fall semester to the end of Fall semester. These gains were made in both the TD and the control ME courses. However, the gains were steeper in the TD course. There were also steeper gains for students in the TD course for the acquisition of problem-solving skills. Furthermore, there were even larger gains for minority students in trust, creativity, collaboration and engagement in the TD course. In fact, the gains in trust and engagement for minority students were greater than the gains of both minority and white students in the control class; and were also greater than the gains of the white students in the TD class. A deeper analysis of the pre/post-test results are provided in the authors' forthcoming publications.

6.8 TD and Gains for Engineering Students

While many of the results around workforce readiness and engaging minority students, developed from *this* study, are published elsewhere, it is worth noting that multiple studies have found that the types of curriculum and pedagogies deployed as part of TD teaching and learning have shown to improve workforce skills and engagement among all students, but particularly for minority students.

TD content pedagogy provides students with the opportunity to not just learn about engineering – or any other subject – but to *become* an engineer; to grapple with the same sorts of complex issues and interdependencies that exist in the workplace. Hager and Hodkinson (2009) argue that the opportunity to see one's self as actually *doing* a profession or skill, rather than *learning about* a profession or skill, tends to create more engagement in a learning environment and greater efficacy once a student is practising that skill in the workforce. Boud and Hager (2012) have shown that, if students can gain practice around a particular concept or skill by actually doing work that involves that concept or skill, the student develops a deeper understanding and the ability to critically and creatively apply those skills or concepts in the workplace. Clark and Zukas (2013) concur with this idea; they describe best practices around learning that will be applied in real-world contexts as 'becoming "a fish in water"' (p. 208). That is to say, the best learning happens when students are placed into a position where they are trusted to operate within the mosaic of competing and interconnected ideologies, policies and questions that occur in real life. TD content pedagogy provides this type of learning environment; TD

requires collaboration, trust, and the humility to seek knowledge and understanding from outside of your own discipline.

Multiple studies in the field of education show that creating collaboration and spaces for students to work with and be challenged by each other can create real learning gains – deeper understanding and better retention of concepts (Aukrust, 2011; Brophy, 2011; Morrow, Gambrell, & Duke, 2011). Current research on cognition (Aukrust, 2011; Morrow et al., 2011) underscores not only the need for students to talk to each other and to feel comfortable and supported by each other, but also for students to develop their own thinking by *hearing difference*; that is, by seeing things from multiple perspectives. An environment that facilitates learning from each other, talking with each other and hearing multiple – and diverging – experiences and ideas leads to more engaged and motivated students, to better learners and deeper learning. This is exactly the type of environment that is promoted by TD-based pedagogy. And, in our study, we have seen that TD methods truly can lead to increased collaboration, sharing of differences and trust.

Educational research has also shown that pedagogical strategies which promote collaboration are particularly beneficial to underrepresented students. Pedagogical methods that consciously create opportunities for collaboration, opportunities for learning from each other, opportunities for working in small groups and opportunities for multiple types of learning, have been shown to increase engagement and the retention of underrepresented groups (McCaleb, 2013; Melnick & Zeichner, 1998). Students who may not otherwise feel comfortable interacting in a standard lecture-based class tend to have the most gains when instructors employ methods that focus on interaction and the bringing together of multiple types of knowledge and interaction. Nelson (1996) argues that, particularly in science, technology, engineering and maths (STEM) courses, it is important to create spaces for students to be creative, collaborate and find their own voice, and contends that most traditionally-taught STEM courses are unintentionally biased against minority students. Because TD methods aim to encourage multiple types of collaboration, nurture multiple perspectives, create safe environments for diversity and develop communities of learners that span students, academics and professionals working in the field, TD is ideal for creating the type of environment that is nurturing to underrepresented people in STEM. This study validates this claim: that TD methods support the learning of underrepresented groups.

More than increased collaboration and engagement, TD content pedagogy was shown – in our study – to create moments when students had to grapple with seeing problems – and even the world – in new ways. TD content pedagogy created moments for students to be ‘pulled up short’.

6.9 Gadamer and Learning: Being Pulled Up Short

Hans Gadamer, a linguistics philosopher, wrote about the *process* – the complex interactions – between a person and the world that take place in order for learning and comprehension to occur. While Gadamer's scholarship specifically focuses on textual understanding, his insights have often been taken up by education theorists in order to understand better the learning process more broadly.

Gadamer et al. (1975/2004) argues that, in order to make sense of the world, we rely on our own background experience as an initial grounding for our understanding of what is being said or what is happening in a specific moment. This background experience is an amalgam of our own personal experiences, family expectations, cultural milieu, and the fact that we are always embedded within a specific historical and geographical moment. Consider, for example, how you might decide what to do upon entering someone's home for the first time. Do you take off your shoes when entering the home? Do you put your shoes by the front door or over to the side? Do you automatically hand your coat – assuming you are in a place where you are wearing a coat – to your host, or do you wait to be asked by your host for your coat? How you negotiate this moment – of crossing the threshold of someone's home – depends heavily on your own family culture, your past experiences at other's homes, your national cultural mores, and your specific historical and geographical moment. This embeddedness in tradition, history and culture helps us to make sense of a new situation or concept. Research in neuro- and cognitive science bears this out, that when we have a new experience our brains automatically try to react to that experience by categorising the experience using existing schema that we have developed through past experience (McClelland, 2013; McKenzie, Robinson, Herrera, Churchill, & Eichenbaum, 2013).

Gadamer argues that comprehension is always historically and culturally situated. Gadamer et al. (1975/2004) states, 'We are always situated within traditions, … It is always part of us, a model or exemplar, a kind of cognizance' (p. 283). He goes on to write, 'Understanding is to be thought of less as a subjective act than as participating in an event of tradition, a process of transmission in which past and present are constantly mediated' (p. 291). For Gadamer, understanding or comprehension is always a negotiated process of revision and interaction between a person – and his/her history, traditions and expectation – and another person or object. Understanding is always a process of wrestling and revision between expectations and new information provided by the object or subject that we wish to understand.

Gadamer argues that comprehension necessitates the willingness to revise and reorganise expectations. In every moment of communication, a person relies on forms of personal bias to understand, and yet that bias must always be open to correction and alteration. Gadamer et al. (1975/2004) writes:

> A person who is trying to understand a text is always projecting. He projects a meaning for the text as a whole as soon as some initial meaning emerges in the text. Again, the initial meaning emerges only because he is reading the text with particular expectations in regard

> to a certain meaning. Working out this fore-projection which is constantly revised in terms of what emerges as he penetrates into the meaning, is understanding what is there. (p. 269)

He continues:

> Every revision of the fore-projection is capable of projecting before itself a new projection of meaning; rival projects can emerge side by side until it becomes clearer what the unity of meaning is; interpretation begins with fore-conceptions that are replaced by more suitable ones. This constant process of new projection constitutes the movement of understanding and interpretation. (p. 269)

In other words, while we come to every moment of comprehension with our own situated histories as the basis for beginning to understand, the process of understanding also demands that we look and listen, and reorganise our expectations based on what is happening in the moment. Gadamer shows us that – to use the colloquial phrase – communication is a two-way street. Communication and comprehension are always an interaction with another person or object.

While the normal – almost mundane – acts of communication that we experience always involve some process of revision toward understanding, there are also moments where the object or person that we seek to understand creates a moment of such alterity that, for a moment, it is not intelligible to us. There are moments when the customary pattern of listening, projecting and revising projections that occurs through normal comprehension processes is inadequate. There are moments when we are stopped in our tracks and we must reorganise how we see the world. This moment is what Gadamer calls being 'pulled up short'. He writes:

> How do we discover that there is a difference between our own customary usage and that of the text? I think we must say that generally we do so in the experience of being pulled up short by the text. Either it does not yield any meaning at all or its meaning is not compatible with what we had expected. This is what brings us up short and alerts us to a possible difference in usage. (Gadamer et al., 1975/2004: 270)

Gadamer contends that the experience of being 'pulled up short' is immediately an experience of loss. The 'experience is initially always an experience of negation: something is not what we supposed it to be' (Gadamer et al., 1975/2004: 354). We feel the moment of realising that things are not what we thought; we realise that we are at a moment of newness and that our past experiences are inadequate to fully make meaning of the moment. This moment, hopefully, creates a sense of openness where we attend more fully to the object or person we seek to understand. The moment of being 'pulled up short' necessitates a change. It can be a relatively small change to how you see the certain concepts or people, or it can be a more seismic shift of your world view.

As Warnke (1987) explains, being 'pulled up short' means that we experience an error or partiality in our previous views and we experience this in such a way that we cannot go back to thinking as we did before. Once we have been pulled up short, we cannot go back to the way we saw the world before being pulled up short. We have a new normal, until we are pulled up short again. However, once we have undergone the process of being pulled up short, proximal to that moment, we have

a new sense of humility about our own expectations. We are open to the idea that the world may not be as we expect it.

It is this moment of really being open to change – a change in world view or a reorganisation of schema – that fascinates many educators. Teaching, at its very heart, aims to create moments for students to be open to shifting their views and reworking their understanding.

Many educational theorists and practitioners have relied on Gadamer's concept of being 'pulled up short' to frame what it means to learn. Kerdeman (2015) describes the moment of being pulled up short as that moment of self-doubt that is necessary for deep learning to occur. That doubt is what allows new understanding to emerge. Kerdeman (2003) also argues that being 'pulled up short is painful and involves a change in world view that unlevels, disconcerts, and is unwanted – but necessary for learning' (p. 208). 'Being pulled up short thus disrupts self-inflation, betraying false pride, invincibility, or exaggerated desire for control.'(Kerdeman, 2003: 210). Being pulled up short allows us to be cognisant of the fact that understanding, identity and knowledge are never stable, but are dynamic, evolving and becoming. This openness to change sets the learner up to better listen to and *hear* difference.

Other education scholars also argue that being pulled up short is necessary for deep learning. Johnson (2013) characterises the moment of being pulled up short as the moment when we must come to grips with our own prejudices and the ways that our prejudices inform our understanding. Johnson (2014) further characterises being pulled up short as a moment that is necessary for any scientific inquiry. Being pulled up short creates a moment of 'difficult tension between (1) the way in which the human person is fundamentally dependent upon convention and, more broadly, historical and environmental situatedness, for existence and (2) the way in which human action is not fully predetermined by this dependence.'(Johnson, 2014: 31). Pohlman (2016) characterises being pulled up short as 'to being blindsided – caught off guard – as a result of our own sometimes blurry lens', but it is this moment of recognising our blurry vision that allows us to try to see things in a different way (p. 8).

Being pulled up short involves exposing a blind spot. It is the moment when your own understanding and expectations fail to encompass the circumstances with which you are faced. It is the moment where you have to rethink. In order to create or facilitate those moments of being pulled up short, teachers aim to create moments of disruption, conversation and openness to difference. This type of teaching and learning, we argue, based on our study, happen as a natural part of TD content pedagogy.

6.10 TD Content Pedagogy and Being 'Pulled Up Short'

TD content pedagogy provides moments for being pulled up short because TD content pedagogy necessitates a stance of interdependence and being open to difference. TD requires thinking about problem solving from multiple viewpoints and seeking out tools, practices and knowledges from multiple fields in order to come to question and evolve solutions better. TD requires that TD devotees find others who have knowledge that they do not have and that they listen and try to gain from that knowledge as they work on complex issues. TD content pedagogy requires students and teachers to aim to see the world from multiple perspectives, and that they are open to difference.

In our study of the TD mechanical engineering course, during the interview process many students talked about the different ways that they had to learn new ways of doing things and new ways of seeing the world as part of the course. Some of the ways that these students experienced newness – and experienced the position of having to be open to newness – were more mundane. One student with the pseudonym Jim expressed an original discomfort with a class that required such a high level of collaboration and learning from fellow students, rather than learning from the teacher. However, Jim noted that, after a while, he came to enjoy the ability to 'work with people close to you' and do 'creative work at your own pace'. He described being much more 'open to the democratic process' of working with and listening to others. Jim believes that this course prepared him for the workforce, because he was put into a position where he had to find some things out on his own, he had to work with others and he had to find a way to negotiate different ideas into a project. A student with the pseudonym Ken had a similar experience. While Ken was not used to a class being taught this way, he came to like the fact that the necessary practice of listening to other's expertise and experiences changed and 'opened up the discussions' within the course. Ken describes the TD course as one where he had to learn that it is 'important to understand multiple aspects of a problem'. Many of the interviewees expressed the idea that the TD course opened them up to the necessity of getting multiple perspectives, and multiple knowledge experts, to work together toward better design. This new view of the design process may help these students as they move forward with their careers, but they are less seismic or unmooring in their change of world view. However, in addition to changes in how they now see what counts as a good design process, many students also expressed a real shift in how they see and understand the world because of this TD course.

Many interviewees pinpointed moments when the process of designing the eco-railway – while also considering its impact on the environment, specific groups of people and society more broadly – blindsided them. Interviewees discussed not knowing the environmental impact that multiple forms of transportation have on the planet and on the people who breathe the air in large urban regions. Many interviewees also mentioned being caught off guard by the social implications of where you lay track for a railway and how much you charge for a ticket. Multiple students talked about being unaware of how SES shapes access to transportation. These

students expressed new concern for how engineering design can work to exacerbate or ameliorate social inequality.

More than that, several interviewees expressed a shift in how they saw the importance of diversity. As researchers, we admit to a bias that predisposed us to believe that many of the young, middle-class white males would not see the value in having more diversity in the classroom. However, we were 'pulled up short'. While there were a few interviewees who talked about the comfort of having mostly white male, mostly native English speakers on the course, there were many who ended the course with the conviction that the design process – and the course in general – would have been more meaningful if there had been more people in the class with different life experiences, different knowledge bases, different geographic locations and so on. Jim specifically called for more 'diversity and people with different demographics' in order to make the course better. He wanted to work with fellow students who had different backgrounds from himself. A student with the pseudonym Carl directly challenged the idea that it was good to have students with the same background experience in a course. Carl noted that, while the similarities of cultural backgrounds 'may have made communication a little easier,' he also noted that this meant that 'everyone in the course had the same perspective'. In the interview, Carl advanced the idea that more should be done to bring diversity to the student population so that all classrooms could have the opportunity to interact with difference. Carl expressed the fact that he had not thought much about diversity until this course, but this course made him consider what other perspectives might mean for design, and this engendered a moment of reflection about the importance of gaining diverse perspectives and hearing diverse voices more broadly.

TD content pedagogy created opportunities for these students to hear difference, work in an environment where they had to seek out knowledge from others and created moments when students could consider how their own background experience did not adequately prepare them to understand how engineering design can affect society. They had to put themselves into the vulnerable position of seeing things differently, and this positon allowed many of the students to have a moment where they were pulled up short; where they had to consider anew their own experiences and the importance of diverse perspectives.

6.11 Conclusion

There are multiple implications for practice that can be drawn from our study. The TD classroom experience provided students with opportunities for: the 'pulled up short' moment; seeing of each other's view and the importance of diversity; understanding the complexity of social problems and the need for complex solutions; and preparation for the workforce by providing realistic experiences. This grounds the idea that more research should be done on the efficacy of TD content pedagogy. This study partially addressed a gap in experimental design research studies on TD,

but more research should be done to explore and analyse reliably the challenges and benefits of TD content pedagogy. Should TD content pedagogy continue to be shown as efficacious for deeper learning, then curriculum and pedagogical changes would need to be made so that more courses incorporate TD content pedagogy as part of the learning experience.

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Chapter 7
Integrating Architecture and Crime Science: A Transdisciplinary Challenge

Hervé Borrion and Daniel Koch

7.1 Introduction

Whatever the complex reasons driving it, emergence of new transdisciplinary fields seems to be justified by the same expected outcome: greater connection with the researchers and practitioners working on particular applications and societal problems (Hoffmann-Riem et al., 2008; Jahn et al., 2012). As an example, crime science emerged from combining knowledge from established disciplines (e.g. psychology, criminology and statistics) to better identify and disrupt the causes of crime events (Wortley & Mazerolle, 2008: 10). A similar claim could be made about the relation between safety science and psychology, engineering and statistics.

Those reformist aspirations are not limited to creating new names for specialised areas within existing disciplines. Theorists in philosophy and sociology of science identified that inter- and transdisciplinary research initiatives often involve identification of shared/complementary research objectives; comparison, combination or integration of research methods or techniques; and aggregation of research findings from *across* disciplines (Porter et al., 2006). In education, they take the form of overhauls of programme curricula and involve specifying what should constitute the core knowledge of those new discipline (e.g. Brantingham, 1972; Chau, 2007; Croskerry, Wears, & Binder, 2000; Smith, 2001).

At their heart of those reforms is the idea that establishing a new discipline would encourage greater connection between fragments of scholarships currently scattered across academia, and foster communities of scholars and practitioners better

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equipped to understand, apply and advance this knowledge (e.g. Komiyama & Takeuchi, 2006).

In the absence of a shared framework, those initiating such interdisciplinary activities often face challenges in making the pieces of the different puzzles fit together. For this reason, many researchers have proposed effective ways to encourage inter- and transdisciplinary research work.

7.2 Aim and Scope

That problem-solving frameworks can play a role in supporting inter- and transdisciplinary thinking is not a novel idea (e.g. Heitmann, 1996; Neuhauser & Pohl, 2015). However, with the exception of a few articles (e.g. Johnson, Sidebottom, & Thorpe, 2008), it is not one that was greatly exemplified in the crime science literature.

A few decades ago, Rossini and Porter (1979) indicated that 'interdisciplinary research lacks the paradigmatic success stories which accompany nearly every disciplinary research tradition'. Since then, such success stories were created and shared in many domains, but not in crime science. For example, no theoretical piece has been published about the benefits of using a problem-solving approach to facilitate transdisciplinary research and teaching activities in crime science. Similarly, crime science has not been the focus of any research on transdisciplinarity.

To start addressing this knowledge gap, we draw upon our experience of working on a three-year research project in the area of counter-terrorism. Specifically, the foci of this article concern the connection points between architecture and crime science, and the application of scenario-structuring methods as a means to reveal them.

In the next section, we introduce these fields and outline the main challenges found when attempting to combine them. The section that follows examines how a problem-solving model was used to overcome those challenges. Finally, we synthesise our observations in a list of recommendations for the development of a transdisciplinary curriculum that could support collaborative work between architects and crime scientists.

7.3 Fields Discussed in This Chapter

7.3.1 Crime Science

Crime science emerged at the start of this century as an interdisciplinary field dedicated to the advancement of knowledge supporting crime detection and crime reduction (Junger, Laycock, Hartel, & Ratcliffe, 2012). Several fundamental

elements of its scholarships come from pioneering works conducted in environmental criminology – a branch of criminology that examines the 'criminal events and the immediate circumstances in which they occur' (Wortley & Mazerolle, 2008: 1).

In practice, crime science departs from traditional criminology in its primary mission (immediate crime reduction vs. long-term social reform, problem-led vs. theory-led), main theories (near causes vs. distant causes, criminal choice vs. criminal dispositions), contributing disciplines (economics, geography, biology, planning and computer science vs. sociology, psychiatry and law) and research methods (analysis of spatial and temporal patterns of crime vs. cohort studies and regression analysis) (Clarke, 2005).

The relation between crime and crime science is analogous to that between disease and medicine/medical science (Smith & Tilley, 2013: xix). Inspired by operations research (Wilkins, 1997), crime science seeks to make use of all relevant disciplines from across the natural and social sciences to achieve its mission. Traditional engineering disciplines, material sciences and chemistry are all instrumental to the development of security technologies and design of goods less likely to be stolen/misused; mathematics, statistics, machine learning and operations research offer analytical models and techniques to model relevant phenomena (such as crowd behaviour or dispersal of a bio-agent), detect threats and anomalous emails and behaviours (such as spam or malware), to optimise the deployment of crime control measures and so on.

To organise crime reduction practice, crime scientists developed frameworks inspired by the problem-oriented policing approach proposed by Goldstein (1979). Among those is a problem-solving model known as scanning – analysis – response – Assessment (SARA) (Eck & Spelman, 1987: xx). The first stage is concerned with identification of recurrent crime issues and potential risks. The second stage seeks to identify the causal mechanisms that must be disrupted to stop the crime commission process. The third comprises the identification/development of an intervention and its implementation. Finally, the fourth stage aims to evaluate how well the intervention was implemented and what effects it had on the problem of interest. While SARA is not the only model available to crime reduction practitioners, it is widely regarded as a simple and useful guide (Sidebottom & Tilley, 2011).

7.3.2 Architecture and Spatial Analysis

Architecture, the other field discussed in this article, can be understood as concerned with that which pertains to built forms and their becoming, where the latter sometimes is in a narrower sense focused on deliberate and culturally self-conscious making. As a theoretical discipline, it therefore encompasses the design of (i.e. giving shape and form to) buildings, cities and other built environments. In addition, it studies discursive fields regarding architecture and cities, as well as the discipline of architecture and its boundaries, built environments in a wider sense, and the effects of society on both discipline and built form – and, conversely, the way the discipline

and built form affect society. It is highly marked by the modern movement, which explicitly incorporated then-recent engineering sciences and sociology into the discipline, and the subsequent rejection and critique of the principles, ideals and solutions of this movement.

Architecture can thus be seen as analogous to crime science in that it draws upon several disciplines from across natural and social sciences, but also from the humanities and arts, for its research and practice purposes. It is conditioned by this multifaceted character and contains within itself artistic, humanistic, sociological and technical research traditions, but these traditions are arguably adapted to architecture as a making field (Allen, 2000; Cross, 2006; Dunin-Woyseth, 2002; Nilsson, 2013, 2014). That is, knowledge from other fields is incorporated insofar as it can contribute to one or both sides of the dual of *possibilities for, limitations to and processes of giving form* on the one hand, and *effects of form on society and culture* on the other hand, with a particular presence of a discourse about the discipline and field 'as such'.

Within this broader field, this article builds a fair share of its reasoning around the architectural field of spatial analysis (see Marcus, Westin, & Liebst, 2013), with its explicit roots in a theoretical and pragmatist critique of modernism, claiming that rather than working scientifically it had worked with artistic interpretations and aesthetics of rationality (Hillier & Hanson, 1984; compare Wigley, 1995). The field was largely defined as studying how the configuration of space 'provides the material preconditions for the patterns of movement, encounter and avoidance which are the material realisation – as well as sometimes the generator – of social relations' (Hillier & Hanson, 1984: ix).

While the origins are decidedly structuralist, the use of graphs and mathematics to analyse configurations has increasingly brought it closer to systems sciences, on the one hand, and empirical social sciences and geography, on the other. In comparison with other architectural fields, it has an emphasis on corroborating theory and claims through empirical data and statistical correlations, but even so it has a strong qualitative character. This offers tangible possibilities for interdisciplinary work, such as with crime science, as it deals with concrete links between built form and social processes/behaviours.

7.3.3 A Challenging Combination

Treating architecture as a problem-solving task has over time proven highly problematic. Although such attempts have been made (see e.g. Alexander, 1964; Wade, 1977), they often led to unintended results.

While not always in a problematic sense, the most well-established case here is arguably modernist urban design and architecture, which largely introduced rationalisation into problem solving and the idea of a rational process for deriving solutions as solving sub-problems and combining the results, as well as the idea that specific spaces or forms respond to specific problems or use-aspects (Emmons, 2006;

Forty, 2000; Koch, 2014). Attempts to theorise and critically develop such a general approach were also made (e.g. Alexander, 1964; Cross, 1977), but they were also swiftly questioned (e.g. Bauer, 1934; Jacobs, 1961; Schön, 1983; Scott, 2010).

Those early attempts largely formulated the approach used in many disciplines, and structured it as a rational process from analysis to product in the ASED-model (Analysis, Synthesis, Evaluation, Decision; see further Cross, 1977; Jones & Thornley, 1963) and has continued through the design methods movement.[1]

The concept of the ASED-model (and similar rationality-based design methods) is largely built upon the principle of decomposition and integration: breaking down a problem into its components, solving each part and synthesising the result into a whole solution.

While one of the main issues with this model is that it leaves the synthesis part undefined and largely undescribed and black-boxed as a process (Koch & Miranda, 2014; Lundequist, 1995), this is not the issue at stake here. Rather, the weakness of the approach can be briefly outlined in four steps. The outset here is that, by default, rather than being technical solution to functional problems, architecture is a material response to a wide range of complex social, economic, functional and technical processes (e.g. Anderson, 1984; Grierson, Edquist, & Frichot, 2015; Krippendorff, 2006). While some of these are possible to break out and compartmentalise to sub-problems, a large portion cannot so easily:

- Architecture as a socio-spatial interface – To a large extent, architecture is made as a response to socio-cultural relations; an attempt to materialise the relations and conditions in a way that both supports and reifies these relations while allowing some degrees of control and flexibility (Foucault, 1986; Hanson, 1998). However, the social and cultural relations and processes that architecture is made to house are extremely complex and under constant renegotiation. In addition, they are often non-reciprocal and non-isoform. That is, the relation between friends can be in conflict with relations between family members – relations between family members can look different, depending from which family member the relations are understood – and they change over time. Therefore, the material response to these relations will at best be an approximation that responds to enough of the relations deemed important, while not disrupting too many others, forming a meaningful whole that subsequently serves to stabilise and maintain relations (Koch, 2013; Markus, 1993). However, as these relations are in constant renegotiation, there is a constant risk that the material response to these relational structures becomes problematic or no longer meaningful. This is usually responded to by the social constellation moving out or that a building is rebuilt. At times, this involves changes of whole types (e.g. schools, churches) while at other times it concerns individual or small-scale changes. These conditions furthermore capture one of the risks with sub-optimisations in architectural

[1] It is of interest to note that Alexander (1971) himself in the 2nd edn of *Notes on the Synthesis of Form,* which is one of the central sources for the design methods movement, explicitly objects to the movement's tenets and apologises for any part his work had played in generating the same.

design work: solutions that are too limited in consideration and geared to a narrow range of specific tasks risk causing unexpected issues, even for the overall use that, for example, a building is intended for.

- Architectural form as a proxy of social relations and condition for actions – This state of approximation (or 'proxy') concerns also what is variously termed 'use' or 'function'. Most activities correspond only loosely to architectural form and the other way around. A clear example is while many live in functionalist apartments in the way that they were designed, most people find other ways to live in them just as logical but radically different (Peponis, 1989). This can be understood as 'non-correspondence' (Hanson & Hillier, 1987). This is neither a strength nor a weakness, but a condition of architectural forms. This means that any solution enables, encourages, restricts and makes impossible a wide range of actions, some of which are intended and others not (see Krippendorff, 2006).[2] Following, as a general tendency, the more tailored an architectural solution in to restrict or achieve one thing specifically, the more 'collateral' effects of restriction will follow – that is, the solutions intended to prevent a problematic behaviour might also restrict a range of wanted or even necessary ones. In addition, increasing evidence (Choi, 2014; Hanson, 1998; Hillier, 1996; Markus, 1993; etc.) indicates human action in space is both functional and social, which further conditions the issue of 'problem solving'. The functional action of 'reading' can, for instance, be many different things depending on what is read, in what mood and for which purpose (Verschaffel, 2010). Conversely, every kind of 'reading' may not be possible to do in the same place, depending on its purpose and social character. What this means is that rarely can architecture respond specifically to precise intended uses or outcomes, while always affecting them in both general and specific ways. This conflicting status of simultaneous precision and imprecision here discussed as 'proxy' has been theoretically elaborated by Tschumi (1996) who points to it as an intrinsic character and challenge of architecture.
- Design as a wicked problem – One way to understand why problem-solving may not be considered as an architectural process is discussed by Nelson and Stolterman (2012), as that an architectural design problem is in essence a 'wicked problem'. Characteristic of a wicked problem is that it can never be exhaustively formulated, and that every solution leads to new problems (Rittel & Webber, 1973). While there are additional characteristics, these serve well to discuss 'problem solving' in architecture: how is a rational solution process to address a problem that can never be fully formulated? Together with the proxy and non-correspondence character of architecture, this maps a problem space where there is a range of integrated, interrelated and interdependent characters and effects of

[2] Krippendorff (2006: 108–114) here discusses constraints and affordances, and introduces the issue as: 'Milk crates are intended to transport milk to grocery stores, but designers can hardly prevent unintended uses: as bookshelves, playthings for children, bins to store tools, dividing walls, stepladders, or bicycle baskets. For a homeless person, a milk crate can hold priceless possessions. Tied to a pole with its bottom removed, it is a basketball basket. In the hands of an angry person, it can become a weapon' (Krippendorff, 2006: 108).

any architectural solution. This further points to how, aside some specific parts, work on architectural proposals always needs to operate primarily on the integrated whole as much as or more than with any part-problem (Allen, 2000; Cross, 2006; Lundequist, 1995), and how any part-problem solution may always be invalidated or altered as it is integrated to the whole to provide an acceptable totality.

- Problem solving and problem handling – From the above arguments, it does not follow that there is no rationale to architectural work or that it cannot participate in crime prevention. Of particular usefulness here is the proposal by Jerker Lundequist (1995) to treat architectural work as problem *handling*. That is, that the work of architects concerns handling the problems and negotiating, evaluating and prioritising to reach one of several integrated wholes that respond best to prioritised issues, while conflicting least with others, and where the additional effects of enabling and restricting actions are within as good a range as possible (see further Krippendorff, 2006). Under these conditions, Lundequist suggests that the design process is therefore about elucidating priorities and values too. Here, the value of stringent analytic knowledge must be obvious, as would the input of how various forms of solutions affect possible action ranges or behavioural tendencies. Another way of understanding the process is as a series of research projects (Anderson, 1984), where ideas, ideals and intentions are constantly negotiated as they encounter the material reality that is, the context in which the solution is introduced, and the proxy and non-correspondence characteristics of architecture.

Though this overview of crime science and architecture appear some of the conceptual and cultural barriers to interdisciplinary work. Inspired by Anderson's suggestion, we draw upon a research project to explain how those can be addressed.

7.4 Case Study: Resilient Building and Infrastructure Security

7.4.1 Resilient Infrastructure and Building Security (RIBS) Project

Funded under the European Framework Programme 7, the RIBS project was conducted in 2010–2013 to support EU member states' counter-terrorism efforts. Its aim was to develop requirements for affordable counter-terrorism measures to be deployed in buildings with both public and private functions (e.g. bank branches, commercial centres).

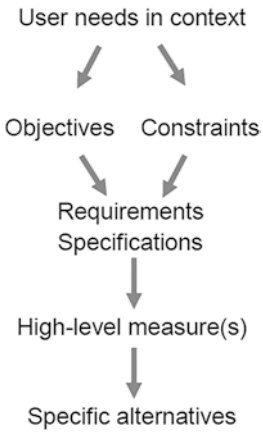

Fig. 7.1 Relationships between stakeholder needs and security measures

7.4.2 Requirements

In architecture, design and engineering, functional and non-functional requirements define the functions that a product (e.g. a security measure) should perform, and the constraints to be met during its development, deployment, operation and disposal stages, respectively (Van Lamsweerde, 2009). Requirement specifications are essential to the effective formulation of design problems, and encourage the conduct of in-depth analysis before potential security measures are proposed (ISO/IEC/IEEE, 2015) (Fig. 7.1).

For the development of suitable products and services, the various constraints defined in the requirements (including legal, political, physical and managerial ones) must be carefully considered. This is particularly important in security applications, as failure to do so would result in poorly effective or even counter-effective systems (Borrion et al., 2014).

7.4.3 RIBS Problem-Solving Model

The influence of the physical environment on security is a well-known relationship. Traces of fortification walls were found in Europe that date back to the Neolithic era (Christensen, 2004). However, it was only more recently, with the introduction of the CEPTD approach (Jeffery, 1971; Newman, 1972), that the modern environmental perspective in criminology was born (Wortley & Mazerolle, 2008: 8). To understand why architecture spatial analysis was considered relevant to this particular research project, it is useful to understand how security systems are designed.

Table 7.1 Process used in RIBS to derive the functional requirements of security systems

Step 1 – Eliciting the high-level security requirements from the stakeholders.
Step 2 – Modelling a set of scenarios relevant to those requirements.
Step 3 – Modelling the decision, initiation and completion stages for each activity in the scenarios.
Step 4 – Carrying out a sensitivity analysis of the selected activities to identify factors of performance.
Step 5 – Specifying aspects of the proposed strategies, control principles and mechanisms to influence those factors.
Step 6 – Determining the response of the various entities to those strategies and updating the scenarios.
Step 7 – Reiterating the previous steps as appropriate.
Step 8 – Comparing the different alternatives and selecting the most suitable ones.
Step 9 – Specifying the effects the measure-to-be should have on the selected factors.
Step 10 – Verifying and validating the functional requirements of the measure-to-be

In RIBS, a problem-solving (or risk management) process model similar to that proposed by Brewer (1999) was adopted to derive the functional requirements of future security systems. A similar process was followed in order to specify their non-functional requirements (Borrion, 2013) (Table 7.1).

7.4.4 Connections with Architecture Spatial Analysis

In Step 1, expertise in architecture and spatial analysis was used to identify the expectations of the stakeholders (e.g. employees, customers) in relation to the space within which future security measures are expected to be implemented. At the higher level of granularity, the studied building was meant to support the organisation's business operations, and thus provide a suitable space for employees to carry out back-office work and deliver a range of services to the clients. Aesthetics, openness and usability of the customer-facing part of the place were all deemed particularly important to support the organisation's business strategy. Equally, employees had certain expectations of their work environment (e.g. practicality).

From those high-level requirements, a number of constraints were identified that would restrict the design of security systems and their operation. Several of them were related to the properties of the building layout, more specifically the configurational arrangement of spaces that allow and restrict movement, and the properties guiding and restricting visibility. As an example, a discovery in this study was the extent to which visitors entered the building without concluding a clear errand – which later was understood as visitors entering to see the length of waiting or if there was an employee available to speak to. This was further discussed with the managers of the place and identified as an important aspect of the business operations in relation-building with existing and potential customers, and for its public image.

In Step 2, scenarios were formulated that represent situations in which the stakeholders' expectations are not met. For example, as employees were expected to access a certain area of the building frequently, we generated scenarios depicting situations in which this was unlikely to happen. Similarly, the management wished to be both symbolically and functionally accessible and close to the personnel, even if direct interaction was sometimes infrequent. Scenarios testing such representational qualities were also formulated. Among those scenarios were security attacks that would cause an area of interest to become unusable or inaccessible for a sustained period of time.

In Step 3 and 6, pre- and post-interventions scenarios were specified in great detail, and the actions most likely to be performed (by the potential offenders, guardians and victims) in different situations identified. For this, spatial analysis techniques were applied that provided in-depth understanding of people's behaviour, including routine activities and exceptional activities. Models were created that represented the spatial practices of the working organisation (i.e. how they were making use of building space in daily operations: who tended to visit whom, what types of work were performed, with whom and where, etc.) and the spatial patterns of visits (e.g. where visitors go, wait, interact and explore; e.g. what places they seek out and where they pass by, etc.), both individually and collectively. Degrees of visibility and accessibility were also assessed to determine where offenders were more likely to conduct certain actions, and where victims were more likely to go. For example, if a weapon had to be stored by an insider or had to be made operational without raising occupants' suspicion, certain parts of the building were considered more appropriate than others to do this.

In Step 4 and 5, the influence that spatial features have on people's behaviour was also taken into account to identify ways in which their movement patterns *could* be modified to support a security objective or *would* be modified as a side-effect of an intervention.

Finally, architecture and spatial analysis expertise was also used to carry out a multidisciplinary assessment of the requirements in Step 8. A crucial step of security measure assessment thereby became for an organisation also to study and understand its own ways of making use of its facilities. Parallel to what could be termed 'generic' qualities of spatial organisation, every organisation has its own way of operating and its own symbolic and functional interfaces with visitors and the general public. Evaluation of security measures must therefore handle both generic qualities and the specific needs and practices of specific buildings and specific organisations. When it comes to how organisations make use of space, there is commonly a lack of self-awareness which then needs to be addressed to ensure that measures do not unintentionally cause problems for daily operations or contradict intended organisational identity.

Table 7.2 Six areas of contribution for architects involved in a security project

Architects can provide information pertaining to the architecture/spatial analysis domains to support:	
(1) Specification of security functional requirements[a]	(2) Specification of non-functional requirements
(3) Contribution to the design of systems that can meet the security functional requirements	(4) Contribution to the design of systems that can meet the non-functional requirements
(5)Evaluation of systems based on the security requirements	(6) Evaluation of systems based on the non-security requirements

[a] In RIBS, security functional requirements represented the functions of the systems that directly contribute to the protection of assets, services, reputation, lives and rights

7.5 Implications for the Course Curriculum Development

As seen with the above case study, tackling societal problems involves elements far beyond the remit of a single discipline (Lattuca, 2001: 8). In an attempt to summarise the role architects that can have in security projects, we identified six areas of contribution represented in Table 7.2.

To engage effectively in security and crime prevention projects, architects should have specific competencies that are conducive to interdisciplinary work. Those are situated on different hierarchical levels and depend on the conception of the role of architects in those projects:

Level 1: The architect as a technical component: On the first level, the architect's role is limited to the application of architectural and spatial analysis techniques, with limited interaction with other experts. This level fits the narrow conception of multidisciplinary work in which 'tasks are carried out by organisationally separate units each of which include practitioners of only one discipline' (Epton et al., 1983: 4). For this, the scope of curricular activities can be limited to equipping students with the knowledge and skills needed to develop and supply information that feeds into a problem-solving framework. Although presented at the lowest level, successfully delivering this information can require them to possess a wide range of technical skills, for example 3D mapping, computing spatio-temporal patterns of movement and occupancy, carrying out shortest path analysis, applying network analysis algorithms to assess resilience to disruption and so on.

Level 2: The architect as a translator: For teamwork, the notion of the architect operating as a component rigidly shaped by their disciplinary curriculum is only viable if they have the skills required for their tasks. Equally, they must understand what other team members need them to deliver. In what is described as 'unidirectional interdisciplinary' projects by Jakobsen, Hels, and McLaughlin (2004), architects may find terminology a real obstacle to the fulfilment of their role. Architects and crime scientists use terms whose precise meaning is known only within their communities: isoform, spatial configuration,

performative architecture, interface, section, elevation, extrude, taper, shear, non-correspondence, crime attractors, crime generators, super-controllers, criminogenic and so on. In addition, terms that are ostensibly the same may have different meanings in different disciplines, such as how 'space' is considered differently in architecture and geography (Forty, 2000; Marcus et al., 2013). Level 2 curricular activities are those that are aimed to familiarise disciplinary specialists with the jargon used in other disciplines. In the case of architecture and crime science, these may include taking introductory courses, reading articles and textbooks, and listening to presentations about work grounded in other disciplines. Describing their own work to the public as well as students and experts in other disciplines should also contribute to facilitating cross-disciplinary communication.

Level 3: The architect as a facilitator: The concept of instrumental interdisciplinarity assumes that knowledge is integrated from across disciplines (Klein, 1990: 42). When an architect contributes to a problem-solving framework, the information that they supply is not always perfectly adapted to the needs of the experts who will use them. Conversely, a very diligent architect who would spend an enormous amount of time generating information with the requested content and format may bitterly realise this was not strictly necessary, after all. In order to arrive at a satisfactory arrangement – and because data requirements can be difficult to elicit – it is useful for architects to understand what objectives the other parties wish to achieve, and how the nature, quantity, quality and format of the data that they receive affect these. Level 3 curricular activities concern the ability of specialists to achieve this. The same logic applies to the data that architects receive as inputs for their work. Since Level 3 knowledge depends on understanding the *aims and intents* of others, as well as its *basis and limits*, curricular activities on that level would focus on deep knowledge (Elmgren & Henriksson, 2014) and integration of *threshold concepts* of the other disciplines into one's own knowledge framework (Meyer & Land, 2003). The target is to move from understanding the terminology of the other discipline to bringing it into *constructive alignment* (e.g. Biggs, 1996) with one's own ways of thinking and working. Level 3 knowledge might be favoured by case studies and group discussions with multidisciplinary groups (e.g. Biggs & Tang, 2011).

Level 4: The architect as a knowledge integrator: The idea that architects can collaborate with other disciplinary experts to reduce criminal risk is an attractive proposition. However, it presupposes that the conditions exist to achieve knowledge integration. For architectural design, for example, requirements from multiple domains must be considered together in order to produce adequate designs. Where crime and the built environment intersect, architects ought to appreciate their dependencies and the mechanisms that connect one to the other. On this level, curricular activities should train architects to identify where architectural features might impact on criminal risk and where criminal events might impact on the properties (e.g. integrity) of built forms. For architects, such activities may include studio projects where crime and crime control are central issues. In that course, criminologists and practitioners may deliver presentations or seminars to broaden the student's experience and draw their attention to specific aspects

considered of importance by crime experts. Then, student proposals could be discussed by both architecture and crime science experts to create a dialogue that helps the students to appreciate the multifaceted character of those problems. Conversely, crime science students could do project work dealing with the physical environment. Seminars could be created with architects well versed in security questions. In addition to threshold concepts and constructive alignment, these learning activities build on *experiential learning* pedagogies (Kolb, 2014) and *active learning* (Prince, 2004).

Level 5: The architect as a coordinator: For all previous levels, it is assumed that a problem-solving model is agreed that will allow architects and other experts to work together. In practice, though, disciplinary experts will favour different approaches, with some of them rejecting the approach selected for the project. To take the role of coordinators in certain tasks, not only architects should have excellent interpersonal qualities but also appreciate the diversity of methodological approaches within a consortium, and find ways to conceptualise their work within the broader problem-solving model adopted for the project. Activities aimed at developing such competencies may include interdisciplinary studio or other projects, where students from different disciplines – in our case crime science students and architects, potentially involving other disciplines such as civil engineers and planners – collaborate on a common task. That task would be *open-ended* (Turner & Paris, 1995) and would require the application of knowledge and skills from different disciplines, and foster the need for students to engage with each other (e.g. Lave & Wenger, 1999). This can take the form of full courses or shorter workshops depending on what is appropriate for overall curricula, where the creation of a 'safe learning environment' (Elmgren & Henriksson, 2014; Hooks, 2014) is a key component to make all students contribute equally, and to foster openness to one another's knowledge and competences and critical reflection of one's own (e.g. Biggs & Tang, 2011).

7.6 Conclusion

The potential for reducing criminal risk through the work of architects is both tremendous and underexploited. In practice, though, collaboration between architects and criminologists is hampered by many disciplinary obstacles. In this article, we have drawn upon our experience of working on a three-year security project to suggest how those might be addressed. Through this bottom-up approach, we have shown that problem solving can offer useful models to identify the competencies that architects must acquire in order to collaborate effectively with each other. To organise those competencies, we propose to adopt a simple framework in which the architect is successively considered as a technical component, translator, facilitator, integrator and coordinator within a crime science project. With this, we hope to facilitate the creation of transdisciplinary curricula that could help to create a new generation of architects, better able to identify criminal risks and work with criminologists and other crime scientists to reduce them.

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Chapter 8
Lessons Learned in Transdisciplinary Graduate Education: Claremont Graduate University's Decade-Long Experiment

Patricia Easton

8.1 Introduction

Claremont Graduate University is engaged in a more than decade-long experiment in transdisciplinary graduate education that positively contributes to a growing, global understanding of transdisciplinarity in higher education, its pedagogy, structure and governance.[1] It is a case study in how Claremont Graduate University has envisioned, institutionalised and measured the outcomes of transdisciplinary education at the graduate level. The case study is unique in that the programme is graduate-only and social science and humanities based. Unlike other transdisciplinary developments in Europe and America, Claremont Graduate University's programme is not grounded in engineering or the hard sciences, but rather in the social sciences, health sciences, computational sciences, business and humanities.[2] The main

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[2] Special appreciation to Dr. Daniel Stokols for his presentations and consultations with our faculty in 2013 on transdisciplinary research and team science. Transdisciplinary approaches in the applied sciences, particularly the health sciences, have been in practice for many years; recently, the emergence of the fields of study and the science of team science provides evidence of the importance of collaborative team work across scientific specialisations. See National Research Council. (2015) *Enhancing the Effectiveness of Team Science.* Committee on the Science of Team Science, N.J. Cooke & M.L. Hilton, Editors. Board on Behavioral, Cognitive, and Sensory Sciences, Division of Behavioral and Social Sciences and Education. Washington, DC: National Academies Press.

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positive findings of the transdisciplinary programme are that: (1) it provides the opportunity for faculty and doctoral students to experiment with methods, ideas and applications that are not provided within their departmental courses and curricula; (2) it fosters the creation of new courses, some which, such as the 'Big Data' course and 'Digital Humanities', have become part of Claremont Graduate University's core curriculum; (3) it fosters dissertation topics through courses and dissertation grants that are transdisciplinary in nature; (4) it fosters transdisciplinary faculty research projects through small grants; (5) it fosters transdisciplinary student projects through small grants; (6) it creates an ongoing transdisciplinary intellectual dialogue on campus through courses, grants, workshops and conferences. The main negative findings of the transdisciplinary programme are: (1) course evaluations that reveal that not all transdisciplinary courses ('t-courses') are successful; (2) faculty leadership that maintains support across the disciplines and university is difficult to sustain; (3) institutional support at the board and executive levels is inconsistent; (4) a vision for the next steps in leadership, academic programming and administrative management is not fully defined.[3]

I begin with a brief history in order to set the groundwork and explain why transdisciplinarity has found fertile ground in Claremont Graduate University's traditions and programme strengths. I provide some examples of how Claremont Graduate University is fostering transdisciplinary teaching and research and what the results are showing us. I then argue that the emergence of transdisciplinarity provides a promising solution to what is a particularly acute *problem of knowledge* facing us in the twenty-first century. Finally, I leave us with some reflections on where educators and leaders in higher education across the globe should be driving transdisciplinary education and research in the future. The upshot of my reflections is that the role of the generalist – or synthesiser – needs to be further explored and capitalised within the framework of the transdisciplinary approach.

8.2 A Brief History: The Transdisciplinary Transformation at Claremont Graduate University and Lessons Learned

To set the stage for understanding the transdisciplinary transformation underway at Claremont Graduate University, we begin in the early 2000s, when George Kozmetsky, a former trustee at Claremont Graduate University, sat with our then-president, Steadman Upham. Dr. Kosmetsky's goal was to persuade him of the

[3] In the Educational Effectiveness Review from the Western Association of Schools and Colleges site visit to Claremont Graduate University in March 2014, the review team declared that Transdisciplinary Studies is a 'key element of the Claremont Graduate University brand' and 'has the potential to serve as a powerful intellectual engine for key aspects of the university's mission.' However, the team also observed 'the success of the programme is contingent upon the active involvement of a critical mass of faculty' as well as 'the energy and practical and administrative skills required for everyday operations.' The team's recommendations for Transdisciplinary Studies at Claremont Graduate University were for the university to build on the current momentum by enhancing leadership, faculty engagement, and programmatic capacity.

importance of transdisciplinary education in a time of hyper-specialisation in research and teaching, particularly at the graduate level.[4] Stead, an archaeologist by training, knew that the specialisation of knowledge brought with it the increased responsibility to synthesise and ask questions that more often than not take us beyond our specific domain of knowledge and training.

As President Upham stated it:

> A 'university of ideas' is founded on the unyielding premise that academic progress and advancement are only possible if teaching and research are organized around the unrestrained pursuit of ideas, wherever they may lead. (*The Flame*, Winter 2003)

Behind President Upham's comments is that with specialisation comes increasing complexity, and with globalisation comes increasing pressure to solve complex problems. If transdisciplinarity is the approach best suited to deal with these developments, then where better to have the necessary debates than at a graduate research university? Or, at a university that is steeped in the Blaisdell[5] tradition of having conversations that matter? Transdisciplinary thinkers such as the late Peter F. Drucker, the father of management theory, Michael Scriven, the father of evaluation science, and Mihaly Csikszentmihalyi, the father of flow and positive psychology, were attracted to Claremont Graduate University for a reason. The campus invites such giants to test their ideas in an intellectually open and collaborative environment.

In spring 2003, the faculty at Claremont Graduate University unanimously voted to institute a four-unit course requirement for all doctoral students. In his convocation speech to the university, President Upham made that case for a required core course for all doctoral students:

> to add a small counterbalance to the overwhelming specialisation of the disciplines. The curriculum of the core course would reveal for doctoral students the interconnectedness of different bodies of knowledge, the unity of the disciplines, and the importance of thinking holistically when approaching complex, multidimensional problems. This kind of core course will foster collaborations among faculty and students while helping each new doctoral student position his or her specialized knowledge on a broader intellectual map.[6]

The new requirement meant that students from every discipline were required to enrol in a transdisciplinary course that would be constituted of students from across disciplines in a course designed around a complex problem or issue. The problem of social justice and poverty was the inaugural theme of the programme. Courses were team-taught and took multiple forms. We learned that, while a course requirement helped to institutionalise transdisciplinarity at Claremont Graduate University, the courses were unwieldy and did not foster the integrative component that we strived for. In truth, faculty steeped in their disciplines were less likely to display the values

[4] It was the vision and gift of George and Ronya Kozmetsky and its reception by President Upham and Claremont Graduate University that led to establishing the George and Ronya Kozmetsky Transdisciplinary Program at Claremont Graduate University in 2004.

[5] James Blaisdell, 3rd president of Pomona College.

[6] Steadman Uphman, 'In Celebration of Claremont Graduate University and Our Unfinished Business.' Speech given at Claremont Graduate University's Convocation, September 2, 2003. (http://Claremont Graduate University.edu/include/2003_Convocation_9-2-03.pdf)

of transdisciplinarity – open-mindedness, thinking outside of and beyond their discipline – than the students taking the class. By 2008, we added a collaborative project around a common question or problem to the design of T-courses. We learned that the structure of a collaborative project was a great pedagogical advance, but needed further faculty development on how to create effective collaborative projects. The fine-tuning of the collaborative component and how to instil a discipline of 'team science' is ongoing. We have also learned that there are two kinds of T-courses: those focused on methods that reach across disciplines such as interpretation, evaluation and data mining, analysis and simulation; and those that are focused on real-world problems such as environmental justice, poverty and inter-cultural and religious dialogue.

8.3 Assessment of the Transdisciplinary Programme and Next Steps

An internal formal review process was conducted in 2012–2013 by the Office of Institutional Effectiveness.[7] The study included a statement of the programme mission, description of the programme; evaluation of the curriculum and scholarship, and report on external relations. The self-study followed the WASC site visit and review that uncovered the strengths and challenges of the programme in its initial phase (2005–2012). To complement these findings, the internal self-study assumed a future focus. Stakeholders identified what the second phase of the programme could and should include. Students and faculty participated in interviews, focus groups and surveys. The self-study included an analysis of the course and award data from the first phase (course evaluations, enrolment trends, student learning outcomes and awarding patterns).

8.3.1 Findings

The findings from both the data and stakeholders clustered around themes, including:

8.3.2 Define Transdisciplinarity

Develop a clear definition of transdisciplinarity for the programme, including the meaning of transdisciplinarity within each course, and for scholarly and research work.[8]

[7] Elements included here are taken from a report by Alana J. Olschwang, Director of the Office of Institutional Effectiveness, who deserves special recognition for her thorough work for this study.

[8] An advisory committee post-review was convened and, rather than define transdisciplinary as 'an

8.3.3 Develop Clear Pedagogy and Application

Integrate theories across disciplines and consider new research methods (how to define problems, apply new methodology, conduct successful group project work, communicate across disciplines and engage in experiential application); facilitate group projects and discussion for a deeper dive into material across disciplines applying high levels of rigour. Course alterations to meet the needs of Masters students should be included. Students provided positive comments in course evaluations about faculty and class discussions. Additional time in class for synthesising and debating viewpoints was recommended.

8.3.4 Expand Transdisciplinary Programme Scope

Expand the scope to connect faculty and students across campus who share research interests. The programme should provide support for networking and development, and faculty mentorship. Increasing the knowledge of what faculty and students are doing across campus will also enable the programme to provide guidance for dual-degree students. In addition to formal coursework, students and faculty recommended workshops, seminars and connection to subject matter experts within and across Claremont Graduate University programmes and discussion groups. Students and faculty would also like to learn from experts from other institutions. Making time and space to spotlight examples of good transdisciplinary work will provide recognition as well as exemplars for future students and faculty. The transdisciplinary programme was initially charged with and should move toward also identifying funding sources and research support.

8.3.5 Enhance Claremont Graduate University Support of Transdisciplinarity

Strengthen the structure around transdisciplinary including budget, research support and incentives; promotion and tenure policies; develop a culture of risk taking to try new approaches; and resources to bring to Claremont Graduate University the transdisciplinary scholarship that has developed nationally and internationally. A common comment from faculty was the lack of time to engage in transdisciplinary

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approach to knowledge, research, and problem solving that takes the core ideas, methods, concepts, and history of at least three disciplines and uses them to study a broad range of problems that no one discipline alone can address', the working definition is now 'an approach to problem-centered research and teaching that draws upon the ideas and methods of multiple disciplines and extends our knowledge beyond any single discipline-specific domain to create new, integrative, and transformative solutions.'

scholarship. A common comment from students was that the transdisciplinary programme attracted them to Claremont Graduate University, however, the programme felt separate from other things that were going on at Claremont Graduate University.

8.3.6 Advance Assessment and Link to Employment

Strengthen connections between the transdisciplinary courses, student learning outcomes and student career trajectories. Student learning outcomes should be explicitly aligned with strategic goals and reflect what is distinctive in a graduate culture. Systematic assessment with director and leadership oversight will enable the programme to use data for decision making and continuous programme improvement. As the award programme increased in popularity, the faculty faced a challenge in selecting the most qualified applicants. Building relationships with transdisciplinary experts and organisations outside of Claremont Graduate University can strengthen the programme. There are numerous regional transdisciplinary programmes that Claremont Graduate University can learn from. Students and faculty do not have a shared understanding of the job market for future faculty members who have a transdisciplinary orientation or the job market outside of academia.

In conclusion, the impact of the t-courses is just beginning to crystallise. We have seen a positive impact in the number of external grants by multidisciplinary teams, as well as students and faculty interested in themes, problems and methods explored in t-courses.

The t-programme has also sponsored conferences, reading groups, small student and faculty grants, dissertation awards, and initiatives to foster transdisciplinarity on campus and beyond. Claremont Graduate University Alumna Emi Makino, of the Drucker Graduate School of Management, in her essay 'Connecting the Transdisciplinary Funding Dots', summarises the effect of each of these T-sponsored activities. (6/22/2012). She writes of receiving a $1500 T-grant that led to the funding of a larger research grant, which in turn led to and was supported with a t-dissertation grant.

In the past 2 years, with my co-director, Tom Horan, we launched two transdisciplinary initiatives. The first is called 'Big Data, Better World?' and the second, 'Innovation and Creativity.' As George Kozmetsky noted, it is important to use initiatives to spark solutions:

> [C]reative management involves abilities to take a problem or crisis and develop its issues, generate alternative solutions, and select feasible initiatives from among the alternatives. Furthermore, creative and innovative management includes the ability to use initiatives as a first step to solutions.[9]

[9] George Kozmetsky, Creative and innovative management: A new academic frontier in *Creative and Innovative Management: Essays in Honors of George Kozmetsky.* A. Chanres and W. W. Cooper, (eds) (Cambridge, MA: Ballinger Publishing Company, 1984), p. 4.

In November 2014, 'Big Data, Better World' was the theme of a transdisciplinary conference, the keynote speaker of which was Jack Dangermond, founder of ESRI.[10] It was also the theme for a new course developed by professors from our information systems and technology programme and our Drucker School of Management. This course focuses on teaching students from across the university to use Big Data tools and technologies effectively across various disciplines and settings, in particular, the social sciences, humanities, information systems, policy and healthcare. Examples of student projects pursued in the course include ones where[11]:

- The student team 'scraped' data from publicly available film databases, in order to answer the following question: Can we use TV show attributes (such as genre, producer/director and time slot) to predict which shows are likely to get cancelled?
- The student team used publically available health data to build a clinical trials 'dashboard.' Using a sophisticated visualisation tool, they created a tool to help users answer 'queries' about clinical trials: Which companies have the most ongoing trials and in which region of the country? What kinds of ailments are getting the most attention, organisationally and financially? What are the companies that are focused on specific, less well-funded ailments? In order to create a seamless user experience, the team had to create a process to download, clean and stream the data into the dashboard on the 'back end'. Their hard work resulted in a remarkably easy-to-use interface that promises to unearth and visualise important information about clinical trials.
- The student team used information made available by the US Department of Education in order to assess the value of an undergraduate degree. They focused specifically on degrees from the University of California (UC) and California State University (CSU) systems, the two largest in the state and two of the largest in the nation. While still preliminary, the team's results suggest that CSU degrees provided greater lifetime earnings, due mainly to the lower cost of tuition.

The Big Data theme also supported the development of a new course in Digital Humanities. Three student dissertation projects have emerged from the initial course offering:

- The first is Alyssa Krueger's *Reviving Irish* project that studies how a literary movement championed by James Joyce and W.B. Yeats helped to revive a dead language, namely Old Irish. Using story maps and other digital tools, she is conducting a thorough analysis of texts and the frequency and use of Old Irish terms.

[10] ESRI is a software company located in Redlands, California. It uses ArcGIS, a location platform to connect people with maps, data, and apps through geographic information systems (GIS). See ESRI http://www.esri.com/

[11] Thanks to Dr. Hovig Tchalian, Assistant Professor of Practice and Director, Drucker Advisory Services, Drucker School of Management, Claremont Graduate University, who provided the details.

- The second is Francesca Gacho, whose project is using GIS technology to track the movement and locations of characters, places of employment and residences of characters in Gissing's novel.
- Finally, Julianna Kirschner is using 'Twitter scraping tools' to understand the usage of the 'Je suis Charlie' ('I am Charlie') hashtag, or #JeSuisCharlie. The goal is to trace the usage of this phrase to see if it is functioning like the phrase that appeared during the World War II in France, namely, 'We are all German Jews'. The generalisation that Julianna is testing is that humans in times of crisis employ the connection of each individual to the common goal, thus fostering unity.

Our second initiative is 'Creativity and Innovation,' launched this year. We have provided seed funding for the development of a jointly taught course on Museums and Heritage with Bath Spa University in England. The students spend 10 days in England working with curators and museum professionals to visit and learn about British heritage; then 10 days in Los Angeles doing the same, visiting sites such as Watts Towers and the Autry museum. The overall goal of the course is to find answers to the question, 'What constitutes cultural understanding?' We are in the planning stages of a conference/workshop on design thinking.

Through all of these activities – student and faculty grants, workshops and conferences, dissertations and course development, we have built a practice and commitment to transdisciplinary approaches to teaching and research. We like to say that transdisciplinarity is in our DNA, it is our intellectual signature. It signifies the recognition that there is a global demand for our graduates to think across disciplines and the growing expectation for flexible thinkers and problem solvers in the global marketplace.

We continue to refine what we mean by transdisciplinarity. The original operational definition was 'an approach to knowledge, research, and problem solving that takes the core ideas, methods, concepts, and history of at least three disciplines and uses them to study a broad range of problems that no one discipline along can address.' Our current operational definition is 'problem-centered research and teaching that draws upon the ideas and methods of multiple disciplines and extends knowledge beyond any single discipline-specific domain to create new, integrative, and transformative solutions.'

Yet, with all of these advances and developments on our campus, the question, 'what is transdisciplinarity' persists. It is often commented that the word alone is unwieldy and certain to fail anyone who tries to say it more than once. Nonetheless, the more than decade-long experiment with the Kozmetsky transdisciplinary programme at Claremont Graduate University has been a great success. The t-course is part of what we do, with an average of 14 courses offered per year. The curriculum, design and pedagogy of t-courses continue to be developed. Our next step is to develop t-practica that are required of our Masters students.

An important next step is to assess how the t-courses and other t-activities tie to student learning outcomes in specific ways and what impact that has had on their career trajectories. This assessment will not only help track the impact of the

t-programme, but also will give us vital information to continually enhance the design and operation of the t-programme in the future.

Undoubtedly, the advancement of knowledge requires specialisation. Specialisation calls researchers to dive deeper and deeper into the subject of their inquiry. It uses terms, concepts and methods that have been developed to answer the increasingly refined questions that we ask. The history of science is rife with examples. The discovery of the living cell in the seventeenth century by Robert Hooke and Anton van Leeuwenhoek was a result of scientists taking advantage of an accumulated body of knowledge in what was called 'natural history,' and the invention of a new tool – the microscope. Independently, both scientists took us beyond what was visible to the naked eye by building on a body of knowledge and using new techniques to scrutinise nature. What biologists know *now* about the nature and function of the cell would delight, as well as befuddle, Hooke and Leeuwenhoek. And questions beyond the study of cells, about how the environment affects cellular function or how to treat diseases of cellular dysfunction, are questions beyond what these thinkers could imagine, let alone tackle. It is without question that specialisation moves the advancement of knowledge.

Yet, with all its benefits, specialisation has a downside. What specialisation did not teach Robert Hooke was how the understanding these biological functions would be connected to the study of the chemical, as well as environmental, psychological and social sciences. The value of cells in the overall ecology of life and human culture was left for not just specialists of many fields, but for their ability to see beyond the boundaries of any one science to connect the dots.

In the words of Henry David Thoreau:

> A man sees only what concerns him… How much more, then, it requires different intentions of the eye and of the mind to attend to different departments of knowledge! How differently the poet and the naturalist look at objects![12]

These words remind us that providing a description of the chemical composition of a cell does not exhaust what is to be known in relation to the cell. The generalist, or the specialist who sees beyond her own specialty, provides an invaluable perspective.

Specialisation, left unchecked, lends itself to the fragmentation of human knowledge. Without the effort to understand across disciplines, we are left seeing the trees without the forest. It may be the trees that make the forest, but the forest and its ecosystem are more than the sum of the parts. It is the indispensable role of the generalist, as knowledge becomes more and more specialised, to bridge the increasing chasm between the details of knowledge and their general significance and connection to other things and domains of knowledge. The special problem for the generalist in the context of the twenty-first century is that it is becoming more and more difficult to keep up – to both be in the world of the specialist, as well as see across multiple disciplines.

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[12] Henry David Thoreau (1817–1862), Autumnal tints (1862), in *The Writings of Henry David Thoreau,* vol. 5: 286, Houghton Mifflin (1906).

I want to turn now to explore briefly how to understand this tension between specialisation and integration in epistemological terms.

8.4 The Problem of Knowledge in the Twenty-First Century that Transdisciplinarity Promises to Solve

With my philosopher and historian of science hat on, I suspect that the emergence of transdisciplinarity approaches to knowledge provides a promising solution to what I think is a particularly acute problem of knowledge facing us in the twenty-first century. With the rapidly expanding body of knowledge and its domains, it is becoming increasingly more difficult to see how these domains relate to one another.

In the history of natural philosophy, now called science, it was generally recognised that there is a dual aspect to the method of attaining knowledge: the method of analysis and the method of synthesis. Suarez, Descartes, Newton, Leibniz and others wrote about the method of discovery as a duality of breaking things down into their simples (analysis) and then connecting those simples into wholes (synthesis). The basic insight was that the world is one whole and yet we, as finite knowers cannot see the whole all at once without the parts. Humans have to break things down to begin to understand them, but then the task of putting our knowledge back together again remains. The dual method of analysis and synthesis paved the way for the study of mechanics in deeper and deeper detail, as well as the formulation of the laws of physics and the universal theory of gravity.

As analysis takes us to deeper levels, breaking a phenomenon into smaller and smaller parts, synthesis asks us to build the parts back up into wholes. As the parts get smaller, so do the wholes. Analysis drives scientific inquiry to see the parts, synthesis to reconstruct the wholes. The importance of synthesis can be overshadowed by analysis in scientific inquiry. This is, in part, because synthesis tells us mostly what we already knew before analysis took place and so it does not seem necessary. It is also, in part, because as we dive deeper into the study of a subject, the complexity of those parts and their relations can obscure what holds them all together.

In the twenty-first century, the depth of disciplinary knowledge – the depth of specialisation – lends itself to an acute problem of knowledge. Unlike in the eighteenth century, it is hard to keep up with the specialised domains of knowledge enough to be able to connect the dots to their interconnections. For example, most of the twentieth-century philosophers of mind went about philosophising about the nature of mind without any grounding in science. Fortunately, by the 1980s, many realised that philosophising without grounding in biology, computer science, or neuroscience was making philosophy of mind an esoteric and irrelevant field of study. Yet, as philosophers delve more deeply into these disciplines, the challenge of connecting this back to the philosophical and value questions has become increasingly difficult. Debates about the 'moral molecule' and the neuro-chemical basis of

emotions are examples of the reductive approach that can arise when analysis is unchecked by synthesis.

If the natural philosophers of the eighteenth century who gave birth to modern science, as we know it, were correct then we should employ both analytic and synthetic tools in our search after truth. The depth and complexity of knowledge in the twenty-first century is unprecedented and I believe requires an approach that crosses disciplinary boundaries as the problem, concept or issue demands. Increasing specialisation, the very hallmark of our success in science, requires more and more of the generalist or synthesiser to meet the challenge of an integrative understanding of the world and the problems facing us today.

I want to end on a note about the value of transdisciplinary approaches to knowledge for the future. The complexity of what is known and the rapidity of growth of that knowledge will only continue to accelerate. It will become harder and harder for any single individual to stay on the forefront of that knowledge. We must collaborate. We must be open-minded to new ideas and new ways of understanding.

Fundamentally, transdisciplinarity is a new way of thinking and doing. Researchers need to be free to follow a problem across disciplinary boundaries. They should be empowered to draw upon the concepts and methods of other disciplines to create new solutions to industry and societal issues. And they should ask how the creation of knowledge can positively impact our most pressing contemporary problems.

As educators in the twenty-first century, our job is to find ways to honour the norms and methods of specialised disciplines and the advances they afford while opening up pathways to reach beyond these disciplines in ways that stimulate innovative and transformative solutions to the world's thorny problems.

Chapter 9
A New Kind of Learning: Somatics, Dance Improvisation and Transdisciplinarity

Vida L. Midgelow

> *If* improvisation is a key way in which humans collectively adapt, communicate, and respond (both consonantly and dissonantly) with their environment; *if* it is a ubiquitous trans-cultural practice that points to an underlying quality of what it means to be human; *if* improvised discourses articulate ideas only to be found therein, testing the limits of our capacity to think new thoughts, to see beyond the constraints of current notions of freedom of expression; *then* there is a profound relationship to be recognized between improvised musical [and dance] discourses and other more expansive discourses in which other forms of human agency are at stake. (Fischlin, 2009: 4)
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> If humanities research and teaching have for too long operated on the flawed assumption that knowledge is a fixed and permanent commodity, then the most absorbing testimony of improvisation's power and potential may well reside in the spirit of movement, mobility, and momentum that it articulates and exemplifies. (Heble & Waterman, 2007: 3)

Academia is still not used to thinking of dance as a form of research and domain of learning that can reach beyond its own specialised field; it is not accustomed to seeing the artist as thinker and knower. Even more so, improvisation remains something of an outsider in the academy and has until recently received little serious attention outside of performing arts contexts – despite the enticing claims by Heble and Waterman regarding its efficacy and Fischlin regarding its significance, in the above citations. Indeed, improvisation might be seen to be resistant to conventional academic attention and certainly eschews codification. It is perceived to be too fleeting, too subjective, too difficult to document, assess and evaluate – too insignificant, perhaps, to bother with too deeply. Yet its significance in the arts is growing and its importance to understanding everyday interactions, pedagogy, well-being, society, business and political action is being recognised. Given this mixed background, how might improvisation find a place within the academy? How might its insights enrich our approach to research, teaching and curricula? How might it offer a new route to learning?

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As I started to think about these questions, I was drawn to reflect more broadly upon how dance, and indeed my own dancing, researching and teaching, have been implicated within the formation of dance within the university more broadly and to consider the nature of knowledge. What has it meant, and what might it mean, to have dance and dancing within the academy? And, as a subset of this question – how might dance improvisation challenge the academy?

This is not the first time that I have mused upon these questions. In 2008, I edited a journal special issue entitled *Entering the Academy* (*Conversations across the Field of Dance Studies*, Society of Dance History Scholars). In the call for this publication, I encouraged authors to reflect upon the implications for dance when shaped by academic institutions. I asked: What happens, for example, to choreographic methodologies when they become honed to a weekly curricular delivery pattern? How are dance styles and techniques transformed when part of degree programmes? In what ways do the requirements of doctoral studies alter the ways in which we reflect upon histories and approach practice (Midgelow, 2008: 3)?

Intersecting with these questions is my longstanding engagement with debates around practice as a mode of research that I have also explored and tested within my teaching and in my own research practice as an improviser. Both of these contexts entail a level of articulacy in/of practice and value the tacit knowledge at work in dance. Such research has put me and my body, and those of my students, at the centre of the enquiry. To borrow from dancer and dramaturge Raymond Hoghe, I have 'thrown my body into the fight' (http://www.raimundhoghe.com). Now, I mean no direct comparison between the needs of Hoghe's body, which is notable due to his upper back spinal curvature and my own. Yet the bodily and the particularities of bodies are core to our lived experience, and this is a significant premise that will resonate throughout this writing. That said, tensions do exist when working from and within the bodily and the experiential in academia. It risks accusations of self-indulgence, subjectivity – even narcissism. Yet, as Roland Pelias notes, the subjective bodily experience 'can be a place where tensions are felt and uncovered, a place of discovery, a place of power, of political action and resistance' (2005: 420).

Taking such risks, I propose a different approach to research and teaching in the university that recognises the ways in which all thinking dwells in a corporeal space and values the processes of the improvised. In what follows, I seek to elaborate the how somatics and improvisation might enable dance as a discipline to be refigured. Further, reaching beyond dance, I consider how improvisation can be understood as a modality to promote transdisciplinary learning. I propose that improvisation as emerging from dance practice has the potential to foster learners who exhibit characteristics that are key to the knowledge economy: deep conceptual and applied understanding, self-awareness and an ability to 'listen', collaborative know-how and flexibility, within frameworks of embodiment, responsibility, play and criticality. Inherently transdisciplinary, these are sensibilities through which students are able to make knowledge their own – for, to adapt the words of Paul Ricoeur, who has said 'feeling is not contrary to thought. It is thought made ours' (1978: 156), improvisation is not contrary to knowledge: it is knowledge is made ours.

In making this argument, at first sight, the responses that place improvisation and knowledge as formed within disciplinary constructs as contradictory worlds need to be unpacked. Disciplinary knowledge implies that we are engaged in a rigid, known world in which we can recognise significance, importance and correctness, and where the distinctiveness of knowledge and how to behave within disciplines are well understood. Improvisation, on the other hand, has tended to be positioned as an approach that is free from boundaries, cannot be fore known, cannot be seen in advance and cannot be ordered in a fixed identity.

However, unlike conventional knowledge formation – knowledge is not understood here as a compendium of fixed things to learn and techniques to master (and I use this gendered term purposefully); rather, knowledge is understood to be dynamic and contextually embedded. As educationalist Keith Sawyer has pointed out, in the current knowledge economy 'it is not sufficient for students to only master a static body of knowledge, our graduates must be must be capable of generating new knowledge, and of functioning in a world where knowledge is always expanding and changing' (Sawyer, 2010: 135).

Equally, improvisation needs to be understood beyond common misconceptions of improvisation as a make do, 'anything goes' activity to reveal that, when entered into critically, is it far from a self-indulgent or totally free practice. As musician and philosopher Gary Peters has argued, the repeated refrain that ties improvisation to self-development (which it might offer) or to freedom (from what? or to do what?) positions it as an 'idealistic (and thus largely ineffective)' model 'that incessantly goes beyond, transcends and breaches the given in the name of the new, the unexpected, the unheard-of and the freedom that is assumed to accompany eternal novelty' (Peters, 2005: 303). Such perspectives limit the potential of the improvisatory gesture in that they fail to acknowledge the ways in which improvisation can offer a method through which critical processes of defamiliarisation and reinterpretation may be undertaken.

Thereby, improvisation is understood here to take place through knowledge of pre-existing forms and/or materials. They are developed through more or less explicit rules, conventions, instructions, abilities, habits, styles and patterns that guide the improvisational performing process. Improvisation occurs not only by virtue of these contextual constraints, but also against and in spite of them, hence the improvisational event should be thought of as dialectical. Its occurrence results from the clash between contrary elements: preparation and invention, planning and surprise, structure and process, legality and spontaneity.

This, rather less idealised, picture enables improvisation to be recognised as a purposeful model for learning and a way in which the intuitive and interpersonal interactions that improvisation promotes can be utilised and understood in contexts beyond the arts. Indeed, improvisation has been taken up in a wide range of fields. For example, discussing the practice of law, Sara Ramshaw draws on jazz to propose that 'every judicial act is, in some sense, a species of improvisation' and

explores the 'uncertain terrain between law and improvisation, between tradition and suspicion' (2010: 1). Similarly, in a reconsideration of inter-organisational working in crisis situations, Benedikt Ley et al. (2012) describe how many situations 'require spontaneous, ad hoc decisions and short-term (re-)planning' (2012: 1529). Improvisation, the writers suggest, supports organisations to be responsive to in situ conditions, noting the shared information and responsibilities that all those involved necessarily carry in order for an improvised response to be effective.

These authors, like many others who have applied the insights of improvisation to contexts beyond the performing arts, limit their outlook to models and metaphors drawn from jazz music (Kamoche et al., 2003). Indeed, somewhat unfortunately, jazz is commonly used as a poor short hand for improvisation per se. While jazz has much to offer, in somatically based dance practices the emphasis of improvisatory work is somewhat different. This somatic orientation uses imagery, touch and movement exploration to reach toward body–mind connectivity, perceptual attunement, autonomy of the body in movement and the integration of the whole person. I will discuss the significance of somatics for transdisciplinarity learning later, but for now it is enough to note that in the context of somatic movement practices, improvisation is a place for exploration, deepening awareness and pleasure in movement.

In what follows, I draw improvisation into debates about disciplinary knowledge and argue that knowledge and knowing can be elaborated through improvisation as an embodied and situated practice. Here learning can take place and knowledge can be undone, (re)generated and made particular, beyond the usual dictates of prescribed curricula and can inform the transdisciplinary for, as a fundamental part of human interaction and existence, it can be said to be a crucial mode through which we engage with real-world contexts. Indeed, as musician George Lewis proposes, improvisation might be said to be as close to a universal contemporary critical method that could responsibly be proposed (Lewis, 2007: np).

Before opening these agendas more broadly to transdisciplinary debate, it is useful, I think, first to consider how improvisation and somatics have been positioned within dance as a field of study in the UK higher educational environment. Whilst this discussion will only be brief, it enables me to note the ways in which a singular disciplinary approach constructs knowledge. In doing so, the importance and simultaneous limitations of disciplinary approaches become clear. Whilst disciplines do shift over time, they need to be recognised as organising structures for and of knowledge production. As such, they reflect organisational operations and disciplinary norms and shape new developments. Significantly, they also orient learners in particularised ways such that they tightly embroil our thinking, constructing ways of being and doing that have to be negotiated, for, as Terry Threadgold has said, 'To succeed in a discipline means to be able to perform its genres and to speak and write and embody its favourite discourses, myths and narratives' (1996: 281).

Given the established tendencies of academic power structures and the values that they perpetuate, it might be that entering and achieving 'mastery' (and I again use this gendered term purposefully) in a discipline means also entering into discourses that are in many instances patriarchal and somatophobic. Therefore, on

entering a discipline we need perhaps to take care not to be seduced into uncritically occupying its disciplinary norms (Threadgold, 1996: 281). Indeed, as we shall see, even in a subject that has been led by women and is as bodily as dance, it is only recently that the importance of embodiment and the potential of improvisation have been taken seriously.

9.1 Dance as a Discipline

Dance has been a discipline in higher education in the UK since the late 1960s. This late entry of dance into the academy stems from social, political and cultural biases that left higher education unwilling to value dance as serious discipline. As Janet Adshead-Lansdale, notes: 'Dancers, dance students at all levels, and indeed, academics, still face the incredulity of others (and sometime ridicule) at their practice of dance, and particularly the idea that it is suitable subject matter for advanced study' (2008: 8). I mention Adshead-Lansdale, as it was scholars such as her, alongside, Layson, Briginshaw and Jordan, to name a few, who successfully fought to establish dance in the British university system.

In *The Study of Dance* (1981), Adshead argues for dance to be studied within the academy and developed a rigorous justification for dance as a subject of advanced study. For Adshead, dance as a form in its many manifestations determines how it should be studied, thereby defining dance as its own discipline (1981: 108). She proposes that dance be understood within three key areas of study: choreography, performance and appreciation. She writes that these areas of study 'concern the development of appropriate theoretical structures; the particular characteristics of the medium of movement and its manipulation into a form; or the criteria of appraisal which are relevant for a given form of dance' (1981: 79). Discussing the significance of Adshead et al.'s text, *Dance Analysis* (1988), Jens Giersdorf, in an enlightening comparative study of the disciplinary genealogies of dance in the academy, suggests that Adshead 'marginalizes choreography and performance in the academic investigation' and continues that, for Adshead, 'only analysis establishes dance studies as "academically viable"' (2009: 34).

Adshead's choreography, performance and appreciation structure continues as a model in UK education and is clearly evident within syllabi for 14–18 year olds in the GCSE and 'A' Level dance examinations. Similarly, Bachelors level degree courses retain this basis, whilst adding different fields of study such as dance science, dance facilitation, community practice and arts management – reflecting both developments in the discipline and the employability agenda that is driving many modern universities.

In these educational contexts, improvisation has been included within particular confines, although it is still sometimes hidden from view. In 'A' Level dance, for instance, improvisation significantly appears only once in the syllabus description alongside task-based approaches to the making of (set) choreographies, whilst in universities improvisation is found fairly commonly within choreography classes

and as a feature of dance training as a way to explore one's own anatomical and individual vocabulary. Students are also regularly taught Contact Improvisation as a dance form which is perceived as a skill that is needed by professional contemporary dance artists in the UK. Significantly, however, improvised dance appears only rarely in history and philosophy modules so, while at least present, improvisation has been fitted into the traditional academic framework within discretely focused practical modules such that its potential to generate a more significant change is limited. Similarly, 'somatics is often squeezed between the seemingly more "important" aspects of the dance curriculum rather than being allowed to lead' (Reed, 2015: 217). Thereby, the reach of somatic improvisation as a transdisciplinary approach, that might offer insights beyond the dance studio, remains untapped.

The prevailing model of dance study, echoing Adshead's construction, perhaps unintentionally tends to place theoretical work at a place once removed from practice – continuing, within a dance context, the typically academic tendency to stratify knowledge and promote theorising over practising – failing to recognise thinking in moving and in doing. This disenfranchisement of practice from theory (and theory from practice) is discussed by Gary Peters in an essay entitled 'Can Improvisation be Taught?' (2005). He notes that 'such an approach seems irrelevant to the day-to-day productive concerns of the artist faced with the reality of making aesthetic judgements (often on the hoof), solving problems, taking chances and capitalise on the unforeseen' (2005: 300).

Despite these difficulties (or perhaps in response to them), there has been a move to embrace (or at least accept) creative practice in the university. We see this shift in the increased attention afforded somatic education and the rise in dance practice as a modality of research. Both these interrelated approaches recognise ways in which meanings and knowledges can be understood and articulated within bodily practices. As theatre professor Robin Nelson suggests, in practice research artists might be understood to be activating a form of 'liquid knowing'. This phrase is drawn from artist Marina Abramovic, who writes: 'knowledge… comes from experience. I call this kind of experience "liquid knowledge"… It is something that runs through your system' (cited in Nelson, 2013: 52). Using this idea to extend our understanding of different modes of knowledge, Nelson suggests that practice as research might develop its own criteria towards credibility and rigour, such that the situated, embodied and haptic nature of coming to knowing might more fully be taken into account.

Perhaps, by understanding the potential of improvisation as an 'investigation of the relationship of self to the world we inhabit' (de Spain, 2014: 13) and as a mode of embodied knowledge, some of the difficulties and obfuscations faced by those who foreground bodily knowing in the academy can be overcome. It may be that we are able to move closer to the lived experience and more effectively recognise knowledge as a process that can be activated by generative and fluid modes of inquiry.

9.2 The Transdisciplinary Project and Embodiment

If we take the position, as I do, that all learning should be an adventure in critically engaged, embodied, experiential and felt modes, it might be that improvisation can show us ways in which disciplines can be undisciplined and the potential of transdisciplinarity can be released. Helping us to think beyond disciplinary paradigms, Basarab Nicolescu is much quoted as saying: 'As the prefix "trans" indicates, transdisciplinarity concerns that which is at once between the disciplines, across the different disciplines, and beyond all discipline. Its goal is the understanding of the present world, of which one of the imperatives is the unity of knowledge' (Nicolescu, 1999: 3).

Indeed, one of the pleasures and difficulties of the transdisciplinary is that it does not try to assert a single meta-discipline or wipe away disciplinary thinking, but to understand how research processes and learning might be undertaken such that we can face real-world contexts and issues. So, while much transdisciplinary thinking has emerged from the world of science, writing about transdisciplinarity as a model for education also speaks closely to arts and aims for an integrated, holistic approach. As such, in addition to expanding disciplinary knowing, transdisciplinary practice places an emphasis on being sensitive to non-cognitive modes of knowing or, in the words of Nicolescu, in developing education for the totality of the human being in which there is an 'equilibrium between analytic intelligence, feelings, and the body' (2013: 25). This notion resonates strongly with thinking around somatic movement education and points to the significance of embodiment in ways of knowing.

Somatic education in dance has developed following the important work of Thomas Hanna, who coined this embracing term in the 1970s. Somatics is derived from the Greek word soma that means living, aware, bodily person and, as a field, dance somatics encompasses practices such as Skinner Releasing Technique, Authentic Movement, Body-Mind-Centring, Eastwest Somatics, Feldenkrais and Yoga (see Eddy, 2009, for a full account). In all these practices, there is a shared emphasis on experiencing from within, mindful study of self and the exploration of movement from the perspective of one's lived experience, encompassing the dimensions of body, psyche and spirit. In these bodily practices, perception is an active and receptive process in which the dancer trains to note interior and exterior worlds in a sensate mode wherein the corporeal and intercorporeal are experienced holistically. Somatically trained artists develop integral bodymind approaches that value the role of embodied intuition, imagination and sensitivity in knowing and knowledge.

In dance education contexts we see somatic practices being integrated into courses as part of performance training, often as part of an eclectic mix of dance techniques and sometimes in more esoteric, fundamentally radical modes – which is of greater interest, in my view (Reed, 2015: 212). Focusing on the whole person, these somatically based modes of training do not generally entail the teaching of set exercises or rote learning. Rather, they offer frameworks for learning through touch, imagery, exploration and improvised movement experiences. Here the 'body

becomes the teacher' (to borrow from dancer Deborah Hay). The ability to listen to and learn from one's fully embodied experiences and those of others guides students to find their own ways of moving without the restriction of codified knowledge. In this way, students are able to explore and discover things for themselves within a supportive, non-judgemental framework. Students are encouraged to pay attention to being present, and how they are present each day and in each moment. As such, students of somatics practice attain 'a state of mind in which there is knowledge of one's own existence and of the existence of surroundings' (Damasio, 2012: 167). Through such states, Damasio proposes that there is the potential for agency and ownership and, I might add, transformation.

Perhaps here, too, we find a connection back to transdisciplinarity, for 'trans' also points us toward the transformative and promotes individual agency within an ethical and caring environment. Somatic practices reach toward change in the person for, as in other art forms, the intent is to be affective. The transformative experience of somatic practices is found not only in the physicality of movement and the ability to reconsider habitual body usage, but also in terms of the whole self – in the physical, emotional and spiritual being. In a teaching context, it seeks to activate the transformative potential of rethinking the self and knowledge in interpersonal, real-world contexts.

Similarly, Nicolescu proposes that transdisciplinary learning 'is a way of self-transformation oriented towards knowledge of the self, the unity of knowledge, and the creation of a new art of living in the society' (1999: 3). This project proposed that universities should 'sensitize students and awaken them to the harmony between beings and things' (1999: 9). Harmony between 'being and things' seems crucial to me in re-envisioning how we educate and how we might reconceive of knowledge and ways of learning.

9.3 Improvisation and a New Kind of Learning

To discuss this further, I reframe the core 'pillars' of new education emerging from the *International Commission on Education for the Twenty-First Century,* as chaired by Jacques Delors, in cooperation with UNESCO. The four key pillars are:

- learning to know
- learning to do
- learning to live together
- learning to be.

Of all the four pillars, the Delors Commission placed particular significance on 'learning to live together', which may be viewed as the fundamental purpose of education. The commission writes:

> Learning to live together, by developing an understanding of others and their history, traditions and spiritual values and, on this basis, creating a new spirit which, guided by recognition of our growing interdependence and common analysis of these risks and challenges of

> the future, would induce people to implement common projects or to manage the inevitable conflicts in an intelligent and peaceful way. (Delors et al., 1996: 22)

Nicolescu's essay, 'The Need for Transdisciplinarity in Higher Education in a Globalized World' (2013), building on his talk 'The Transdisciplinary Evolution of Learning' (1999), elaborates these values and discusses the four pillars in terms of the contribution that transdisciplinarity can make. He proposes that we need 'a new type of education which takes into account *all* the dimensions of the human being' (1999: 4). Here, taking each pillar in turn, I will add somatic improvisation to the picture cast by Nicolescu, indicating how improvisation always and already offers us a way through which these pillars can be embodied and made meaningful in creative ways.

9.3.1 Learning to Be: Embodied Listening and Reflexivity

Nicolescu writes that learning to be entails 'discovering the harmony or disharmony between our individual and social life'. He proposes that 'learning to be' means entering a 'permanent apprenticeship in which teachers inform the students as much as students inform the teachers' and 'learning to know and to respect that which joins the Subject and Object' (2013: 23).

I start with the pillar 'learning to be', as it is a key aspect of somatically based improvisation. A critical feature of coming to recognise and understand ourselves in the world is through processes of suspension and the engagement of embodied listening. Suspension and listening, otherwise called attuning, is what improvisers learn to do in order to facilitate the emergence of materials in the moment. By the temporary suspension of customary thoughts, judgements and impulsive reactions, a space for something else to occur arises. The improviser enters a space without pre-judgement of what might happen, and without a predetermined course of action. In this state of suspension, the improviser waits for things beyond the immediate to rise to the surface and to become apparent. It is from here that she might begin to move. Suspension also entails attentive listening, becoming attuned to that which is within and around us, and entering without presuming we that already know that which surrounds us or know that which we sense within ourselves. Thus, when dancing, the improviser is at a high level of attention and arousal, and aware of the materiality of her dancing, the potentiality of the structures and actions occurring at every moment, and those that might follow.

Implicit in this process are the ongoing reflections that are activated at the same time as the acts of realisation. This in-the-moment reflection occurs as an internal dialogue between the dancer and her experience, her relationship to other dancers and the emerging work. Thereby the reflexive improviser is not someone who merely reflects after the event, but is in engaged in a feedback loop in the process, while dancing. I think the following words of dancer Deborah Hay are again useful here, she says; 'I notice where I am "on automatic". The more attention I bring to

playing, the finer the gaps requiring my attention. Gaps do not cease: they demand greater acuity' (Hay, 1994: 20–21). So, when Hay is 'noticing she is on automatic' in a reflexive mode, this facility enables her to 'pay attention' to the practice rather than just experiencing it. Les Todres might say that she is remaining 'responsively connected to the aliveness of the specific experiential occasion' (2007: 29). This reflexive sensibility, a reflection in the midst (as Merleau-Ponty might say), enables the dancer to remain immersed, deepening the kinaesthetic experience in a purposeful mode. Though small intersecting loops, and with practice, this embodied-reflexivity deepens the dancer's critical engagement with the practice – for through this process it is possible to become more present, in more multifaceted ways.

Being receptive and reflexive are crucial skills for all learners and particularly so if we want to value the whole person and wish to be person centred in our teaching. Being able to attend to 'the what' and 'the how' of that which is happening is an important mode through which practice as knowledge in process is developed in sensitive, informed and meaningful ways. Promoting these skills, we also promote self-awareness, individual responsibility.

9.3.2 Learning to Know: Being in Process

Rather than a pragmatic, end-gaining approach to learning, which might emphasise the result of learning asking, what has been learned? What is known?, 'Learning to know' foregrounds how we come to knowledge and the processes of learning. Nicolescu suggests that 'learning to know' gets at the very heart of enquiry, evoking 'permanent questioning in relation with the resistance to facts, images, representations, and formalizations' (2013: 21).

Improvisation is crucial to such an approach. A key feature of improvised ways of going about things is that the improvising researcher or learner operates in a purposefully developed state of curious unknowing. In this state they seek to remain alive to and immersed in the practice and its context, constantly and playfully exploring from a position that everything has potential and can initiate a previously untold journey. Everything – however unlikely – if we could just be open to it, can give rise to unexpected insights. Such acceptance is one of the difficulties and pleasures of improvisation.

Proceeding through intuition and synthesis, rather than abstraction and analysis, this state of curious questioning requires us to let go of a certain level of control. Being in and alert to process, improvisers learn to be in readiness for change, such that they are able to respond to unexpected shifts. In committing to this process, rather than fixing upon the pre-known, knowing develops in emergent rather than pre-planned ways. Instead of striving to imitate that which has gone before, improvisers continually re-explore, re-test and re-create environments in which that which could not be predicted or pre-known is enabled.

As noted above, this emphasis upon being in process does not mean being without knowledge, focus, intent or purpose. To improvise requires deep practical and

conceptual understanding and an ability to activate this knowledge in creative, diverse and situationally appropriate ways. As creative experts, improvisers are able to note and contribute to the emerging phenomena through their prior knowledge of the practice, such that they can both inhabit and challenge the structures within which they are working. This process enables and requires a significant level of interconnectivity to weave together a complex array of elements and so that the improvised materials being generated can be made meaningful, both individually and with/for others. Developing a capacity to perceive and take responsibility for that which is emerging, in any given the situation, improvisers seek to retain an awareness of how they are individually and collectively (co)generating ideas.

In this way, improvised thinking is deeply embedded, associational, responsive and lateral in nature and, as a transdisciplinary approach, this enables adaptably to change for improvisers enjoy, a level of 'flexibility which is always oriented toward the actualization of their interior abilities' (Nicolescu, 2013: 21). In this process and the recognition of interior abilities, there is a move away from prescribed precepts and away from progress-based teaching, where we assume progression along particular lines, and toward learning processes that are nonlinear and procedural.

9.3.3 Learning to Do: Between Knowns and Unknowns

The emphasis of Delors et al. in terms of learning to do was on the development of skills to enable individuals to contribute to the global economy which, if taken narrowly, might be read as learning to do a job of work. However, if we consider 'learning to do' more generally as entailing the acquisition of competences that enable people to deal with a variety of often unforeseeable situations, improvisation can assist us here, too. As a way of going about things (see Midgelow, 2015, 2017), improvisation is both grounded deeply in knowledge of/in particular specialised contexts and at the same time promotes the ability to engage flexibly and adaptably across all contexts as an encompassing life/work skill that can be widely applied.

As discussed above, despite common misconceptions, improvisation rarely develops in extended and meaningful ways without knowledge of one's field – be that dance, music, law or crisis management. Rather, improvisation is an act of learning furthered by repetition and training, supported by frameworks that scaffold and sculpt the emerging material. The improviser has to be skilful and have a deep understanding of the discipline or form to be able, in the moment, to generate, adapt and to initiate anew.

Improvisation is founded upon embodied knowledge, tacit understanding of genre/form/ context and all one's accumulated knowledges. To elaborate in relation to dance more specifically, knowing one's own bodily potential and habits as formed through training and everyday usage is foundational and, in an improvised context, the dancer's ability to use, adapt and perhaps shift these established movement patterns comes to the fore. Understanding the boundaries or conventions of the form and modes of engagement that it encompasses allows an improvisation to be

recognised and developed within a group – even when choosing to ignore such 'rules'. Further, many improvisations take place within predetermined structures – whether formed by the spatial or temporal situation or as a purposefully generated artistic guide or focus. Such structures shape the improvisation and assist the improviser in 'staying on task', again – even while selecting to 'go off' task! These, and the dancer's life experiences, felt understandings and socio-critical knowledges are known within which the unpredicted or previously unknown might arise.

The improviser is not then constantly operating as if from nothing; rather, the improviser is working to engage with all their embodied histories intact, but from the position that through playful encounters and by revisiting something otherwise or 'as if' anew, ideas and manifestations that could not have been previously imagined might arise. As Santi and Illetterati note, 'a good improviser needs to be brave enough to breach the confines of grammar and believing enough to use it to extend the field of discourse toward new, shared meanings' (Santi & Illetterati, 2010: 4). This is vital to the creative drive of improvisation and is the root of the cross-disciplinary appeals to improvisation. Indeed, as Nicolescu writes, transdisciplinary learning to do has flexibility at its interior core and the development of creativity as its aim (2013: 21) and, likewise, improvisation can create 'the conditions for the maximal actualization of… creative potentialities' (Nicolescu, 2013: 22).

9.3.4 Learning to Live Together: Collaboration, Trust and Ethics

Collaboration, trust and ethical engagement with others are at the heart of improvisatory practice. In dance forms such as Contact Improvisation, these ideas are concrete and explicit, as the form is only manifest through the contact between two bodies, the sharing of weight and mutual physical support. In other somatic forms, touch is equally important, if not always as full-bodied. Here, the contact of one person's hand on the body of another promotes exchange and connectivity with both self and other.

As discussed above, dancers in these practices develop an ability to 'listen', to be open to what each person brings to the group and to note how each person is co-created by, and is co-creating, the improvisation. This reciprocity means that each person's actions are contingent upon what has gone before and that responsibility is distributed across all participants. Similarly, discussing improvised dialogue and education, Keith Sayers writes that knowledge and intelligence 'reside not only in people's heads, but are distributed across situated social practices that involve multiple participants in complex social systems' (Sawyer, 2010: 141). Such distributed systems are non-hierarchical in approach and, in classroom situations, require the teacher to step back and release their control of the class, allowing individuals to learn from each other and to call on the benefit of shared experiences.

Such complex non-hierarchal social systems are not easily established or maintained, as is evident in the evocative words of Enrique Vargas Madrazo and Irmgard

Rehaag in their essay 'Epistemological Awareness and Transdisciplinary Attitude: Experiencing the Embodied Being':

> Obviously, we cannot converse peaceably and creatively with someone we desire to dominate and conquer (be it a body, my emotionality, an 'object of study' or a human being with whom I live). A conqueror has never been able to know and enjoy the delicious pleasures and secrets that make up the subtle story of the 'dominated' peoples. (Madrazo & Rehaag, 2013: 183)

While not focused upon improvisation, they usefully foreground the significance of embodiment and the importance of such truly shared spaces in political terms. This is a reminder of the power of embodiment and that, just as in all forms of human interaction, improvisation has the potential to be both ethical and non-ethical in the manner of its undertaking.

Participating appropriately in improvisation requires that cultural difference is embraced, idiosyncrasies celebrated and normal power relations set aside, for collaboratively successful improvisations are founded upon respect, inclusion and equality. Appropriateness, then, entails working in a non-violent, non-exploitative manner and with a spirit of generosity, for co-creative improvisation cannot be realised without us learning and activating ethical ways of learning to live together. In such environments '"knowing" is reconceived as the ability to participate appropriately in shared cultural practices' (Sawyer, 2010: 141).

9.4 Summation

Dance as a field of knowledge, like any discipline, is a construction. What I have attempted to do is to reveal some of the ways in dance as a field, as it has historically been constructed, has acted as a mechanism to include and exclude particular approaches. Reflecting the renewed recognition for somatics and embodied ways of knowing, alternative structures and pedagogies might be possible. In particular, I have proposed that improvisation – that has long been occluded – might usefully spill out beyond the narrow modular contexts in which it currently resides to inspire alternative ways of approaching dance and toward a transdisciplinary education. This is made possible by taking improvisation out of the margins – by taking improvisation seriously. In doing, so we can reconfigure stratified models of knowledge to promote a natural and substantive integration within the academic curriculum and a rigorous, systematic enquiry, developing embodied and attuned approaches to learning.

To finish, then (and to take us back to Fischlin, who opened this chapter), if improvisation is a crucial part of what it is to be human, and if improvisation is critical mode of inquiry and a model for learning (as I propose) in which knowledge is explored, generated and shared, *then* (dance) improvisation has a significant role to play in our understanding of how we come to knowledge in embodied and emergent, indeed transdisciplinary modes. As a mode for/of transdisciplinary education, I suggest improvisation has far-reaching implications, offering a critical approach that should be at the heart of all learning, in the tissue and sinew of what we do and how we do it.

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Chapter 10
Working in Corners, Spaces, Bends and Turns: How Transdisciplinary Approaches and Attitudes Might Challenge and Shape the Practices of Educational Developers and Early Career Academics

Carole L. Davis

This chapter explores ways in which the practices of educational developers in higher education settings might transcend a role that has traditionally been characterised as training rather than academic, and often perceived as hovering on the borders of subject disciplines (Holmes et al., 2012; Little & Green, 2011). It starts from the premise that educational development should begin to be recognised as a legitimate discipline and ends with an invitation to create opportunities for new forms of transdisciplinary learning within our universities.

10.1 What Is a Discipline and Can Educational Development Claim to Be One?

Becher and Trowler (2001) discovered that defining what constitutes an academic discipline is problematic, because of the vast differences between disciplines. Krishnan (2009) acknowledges this and offers below a general list of characteristics that indicate whether a subject is a distinct discipline, arguing that the more characteristics a discipline has, the more likely it will become recognised as such:

1. Disciplines have a particular object of research although the object of research may be shared with another discipline
2. Disciplines have a body of accumulated specialist knowledge referring to their object of research which is specific to them and not shared with another discipline

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3. Disciplines have theories and concepts that can organise the accumulated specialist knowledge effectively
4. Disciplines use specific terminologies or a specialist technical language adjusted to their research object
5. Disciplines have developed specific research methods according to their specific research requirements
6. Disciplines must have some institutional manifestation in the form of subjects taught at universities or colleges, respective academic departments and professional associations connected to it including professorial chairs. (Krishnan, 2009: 9–10)

It is not within the scope of this chapter to explore in detail supporting arguments and counter-arguments for this claim. However, based on the criteria above, there is supporting evidence for educational development beginning to be recognised as a new discipline. This can be seen in recent trends in creating professorial chairs in educational development.

Educational developers whose practices are rooted in evidence-based theory and applied scholarship regularly occupy a central position in the academy, and are well situated to collaborate with academic colleagues in a meaningful and relevant way. Such collaboration offers the possibility of transcending what would be regarded as merely sound educational practice and model the way for an appreciation and application of the concept of transdisciplinarity. Creating the conditions for emergent new knowledge and a new lens via which to consider it not only enhances the impact of individual disciplines but allows potential for the student learning experience to be improved.

A greater exploration of transdisciplinary practice between educational developers and academics could help to transcend these 'empty spaces' and create a foundation that 'enables us to name its components and see how they fit together as a whole and as a foundation on which to grow and deepen the practice' (Marshall, 2015: 6).

This chapter draws on an adaption of Carper's fundamental ways of knowing as a framing device to generate a clearer and more complete thinking about the potential for transdisciplinary learning and teaching in the academy. Carper's (1978) framework offers four patterns of knowing: empirical, aesthetic, personal and ethical that, almost 40 years later, can be used to support a claim for integrative patterns between discipline pedagogies and the scholarship of teaching and learning (Boyer, 1990). It offers a robust and flexible model for the generic elements of learning and teaching that can be applied to a range of disciplines. Yet a framework is only as good as its operator or, in a transdisciplinary context, its operators; and effectiveness is considerably enhanced by the coming together of educational developers and early career academics.

The author is encouraged by the ideas of Nicolescu, who proposes that binary ways of thinking are not the way forward for the future, and that the time has come for universities to adapt a more transdisciplinary approach to education:

> All the various tensions – economic, cultural, spiritual – are inevitably perpetuated and deepened by a system of education founded on the values of another century, and by a

> rapidly accelerating unbalance between contemporary structures and the changes which are currently taking place in the contemporary world. (Nicolescu, 1997: 2)

However, the chapter also supports a view of the unpredictability and complexity of such work. It stresses the importance of allowing both academics and educational developers to sit with ambiguity (Barnett, 2011), discomfort and frustration, in some circumstances rejecting transdisciplinary practice until both parties have arrived at a place of readiness. As the examples show, the necessary conditions for the way forward would appear to be an ability to articulate clearly the distinguishing features of one's own discipline, whether it is chemistry or educational development. Other optimal conditions would appear to be a willingness to embrace new ways of seeing the familiar, questioning presumptions and assumptions, and a reflexive approach.

Critical thinking and theoretical underpinning is used to analyse and evaluate a case study account of in-depth discussions between one educational developer and four early career academics in the natural sciences which focuses on initiatives seeking to fill the space between natural science pedagogies and the scholarship of educational development. The emergence of an adaptation of a framework based on Carper's ways of knowing illustrates how in the words of Nicolescu (1999) 'a new vision and a new lived experience' might be forged. It is argued that this in turn leads to increased knowledge of self, unified knowledge between natural science subject pedagogies and the scholarship of teaching and learning, along with an alternative of being, both in the world and in the academy (Fortuin and Van Koppen, 2013).

10.2 Educational Development

Educational developers are responsible for the professional development of academics in higher education institutions, and will often have been in academic roles themselves. There is a strong leadership and role-modelling element to their work as they focus on enhancing academic practice in areas that include assessment and feedback, curriculum development, evaluation of the student experience, teaching methodologies and pedagogic approaches. This is usually done through formal programmes, but also bespoke workshops, teaching observation and professional dialogue about teaching and learning. If higher education is a public good, then educational development is a collective good in challenging and shaping the sector (Davis, 2013).

The body of academic knowledge associated with educational development is strongly linked to the scholarship of teaching and learning (SotL). Brew (2010) offers the view that higher education is currently characterised by change, challenge and uncertainty, and offers a panacea in the form of the ideas embedded in the scholarship of teaching and learning (SoTL), as developed by Boyer (1990). What characterises educational development then becomes more than knowledge, but rather the ability to manage change and help create conditions for means for survival in

turbulent times (Timmermans, 2014). Boyer (1990) expresses concern that teaching is viewed as inferior to research, and advocates that research and teaching activity are seen as of equal status and value within the academic role. He sees a way of achieving this through introducing the concept of SoTL, considered to have four dimensions of discovery, integration, engagement or application, and teaching.

One of the natural sciences academics whom I interviewed was of the opinion that:

> It seems to me that educational development is a weak form of a discipline unlike say chemistry or maths which is perceived as a strong discipline…. (Interviewee B)

This statement could be informed by a belief that not all disciplines are equal, together with a perception that the legitimacy of its knowledge might be contested. However, later this same individual confessed to not really knowing what educational development was, suggesting that there was a lack of understanding or exposure to positive experiences.

10.3 The Natural Sciences

The natural sciences are generally taken to refer to a science such as chemistry, biology, geology or physics that involves the study of the physical world and its phenomena. It is a discipline consisting of a number of sub-disciplines that are separate yet overlapping. When asked to offer a definition, the academics interviewed responded in the following ways:

> I do teach microbiology and gene technology, so two subjects and mostly for undergrads. One is the study of living micro-organisms which can be viruses and the ecology and biology of the environment and the other is gene manipulation… (Interviewee D)
>
> When we think about science we think about the basic sciences which are mathematics and chemistry, if you want, which are much less descriptive and more conceptual. After this we move on to more descriptive science which basically, which can be also biology, anatomy… (Interviewee A)

The second quote tells us that within the natural sciences there are different types of knowledge, suggesting different approaches to learning and teaching.

However, what was agreed among all the natural science academics was that taking a natural sciences degree is hard, requiring undergraduates to wrestle to master concepts and theories, yet ultimately rewarding. The following individual captured a view held by all:

> The first couple of years are challenging and then it gets interesting… (Interviewee C)
>
> This is the shape, this is the structure, which is some ways are easier because you don't really need to understand the concept. You can learn the concept immediately after I explain to you. So I explain how bacteria is made… (Interviewee A)

This resonates with the seminal work carried out by Becher and Trowler (2001), who found similarities and differences between academic disciplines, numerous and subtle boundaries between subjects, and also that bridges were being built as

academic 'tribes' adapted to new knowledge and emerging sub-disciplines. This requires moving beyond 'how to teach' and allowing fundamental points about discipline-specific pedagogy to be debated (Barnett, 2011). The author's own experience as an educational developer has shown that knowledge associated with different subject disciplines, context and preferred learning approaches needs to be taken into account in educational development. Teaching the natural sciences is very different from teaching the social sciences or theoretical sciences such as mathematics.

> In the natural sciences we teach in a highly structured way, to the point with clear instruction…. We might clarify and explain, but we don't really discuss or debate… (Interviewee B)

This quote supports a strong conceptual argument against a 'one size fits all' approach to educational development and suggests that, for it to be meaningful, educational development and consequently SoTL must be framed in a discipline. It was recognised that there was specific pedagogical knowledge, but also generic pedagogic knowledge.

10.4 Possibilities for Transdisciplinary Practice

Klein (2000) argues that a transdisciplinary field is characterised by four elements or components:

1. A coherent conceptual framework, lens, or a meta-disciplinary perspective
2. A critique of component disciplines
3. A distinct epistemology
4. An array of particular methods and practices.

How then do educational developers and early careers academics in a specific subject discipline begin to engage in transdisciplinary work with each other? What is needed to create the conditions for 'praxis' and the 'pedagogies of fusion and flow' (Marshall, 2014: 105) that allow us to move beyond the interpretation of academic topics?

Educational developers have at times struggled to develop a critical understanding of the nuances and complexities of subject pedagogies (Davis, 2013). In turn, some academics have struggled to conceptualise the practices associated with the scholarship of learning and teaching, leading to the creation of 'empty spaces' (Nicolescu, 2015). If we are not careful, what is left is an empty space where it can appear that there is no common ground and demarcation lines remain entrenched, as illustrated below:

> When I wrote my narrative overview to accompany my portfolio of evidence for the PG Cert HE the feedback I got was that I was too descriptive and did not take a critical enough approach to my teaching practices nor was I sufficiently reflective… yet I have no idea what this means… (Interviewee C)

Do disciplinary differences bring about tensions, because individuals are being taken out their comfort zone, and are in fact the tensions between the different types of knowledge? The previous quote suggests that this is so. Is it possible that transdisciplinary ways of working can be overcome, as in this following quote? Klein appears to think so:

> Transdisciplinary goes much further. It connotes a practice or domain that rises above disciplines and dissolves their boundaries to create a new social and cognitive space. Transdisciplinarity, therefore, is where deep integration is achieved. (Klein, 2000)

The author believes that there is value in exploring where the potential intersection is with educational development and natural sciences, discussing how the territory is mapped out and their common ground, along with scope for reciprocity and mutuality. Where might there be cojoining of subject pedagogies and subject discipline, so a three step approach involving subject pedagogy (natural sciences) + educational development (SoLT) = transdisciplinarity? There is insufficient time within this chapter to go into depth as to how this might happen, but there is an opportunity to consider the possibilities and to pose the questions that might then inform future practice.

10.5 Carper and Ways of Knowing

It is suggested that Carper offers a potential theoretical lens for the development of a conceptual model of transdisciplinary that will enhance the reflexive skills of those involved.

Because the author's first career was in nursing, frameworks for categorising nursing knowledge have influenced her current role as an educational developer. Carper's (1978) framework offers four patterns of knowing: empirical; aesthetic; personal; and ethical. At the time, the work by Carper was seen as ground-breaking and challenged the limits of a traditional scientific approach to nursing. Carper argued that relying purely on empirical knowledge dehumanises people and fails to get at the heart of what practice is. The importance of framing any educational experience in an authentic manner was emphasised, which is why it is insufficient to rely solely on indicators of impact and performance to measure the outcomes of any educationally based experience.

Carper was interested in making a claim for the existence of integrative patterns. The extensive educational development work undertaken by the author has been characterised by the development of arguments that identify integrative patterns. It is an approach that is intrinsic to creating meaningful relationships with academics and to the effectiveness of specific development practices, such as teaching observation and mentoring.

Carper (1978) argues that understanding the patterns that make up the body of knowledge associated with a discipline provides an essential structure for determining how this knowledge should be taught and learnt:

> Most theory development and research efforts are primarily engaged in seeking and generating explanations that are systematic and controllable by factual evidence and that can be used in the organisation and classification of knowledge. (Carper, 1978: 13)

So this might suggest a tension between how natural scientists view learning and teaching and educational developers do. As the previous quote suggests, natural scientists like order and certainties, whilst educational developers are suggesting a more discursive, flexible approach to the student experience. Educational developers will often see this student experience through the wider lens of social, economic and political factors (Davis, 2013).

Empirical knowing tends to be characterised by the same degree of highly integrated abstract and systematic explanations as characterise the natural sciences.

Aesthetic knowledge includes ways of knowing that are not the results of empirical investigation, but have emerged from knowledge that is tacit and intuitive, embodying a holistic approach. It values experience and trusts subjectivity, seeing the bigger picture and in particular the parts that make up the dynamic integration of the whole. So already we might see how paying more attention to the aesthetic could enhance education within the disciplines by focusing on teaching methodologies, learning approaches and the purpose of higher education.

Personal knowing acknowledges the importance of the interpersonal process, which involves relationships, transactions and interactions between others. Carper was writing about this relationship with the nurse and the patient-client in mind. However, it is easy in this context to view the significant relationships and interactions to be between academics, their students and other colleagues. The quality of interpersonal contact, or lack of it, between academic staff and students features prominently on student evaluation sheets in this institution and would offer a 'growing edge' for academics working with educational developers.

Ethical knowing is the fourth and final dimension, and focuses on matters of obligation or what should be done; that is, choices made, normative judgements, values, consistency, fairness and so on. It links explicitly to authenticity and transparency of assessment, learning gains and social capital.

10.6 The Natural Sciences Academics

The four academics were interviewed, with interviews lasting between 50 and 90 min. Of the four there were two biologists, one chemist and one physicist. They were already engaging in interdisciplinary and, to a lesser extent, transdisciplinary work within their own subject disciplines. They taught in a post-1992 university on undergraduate programmes that combined subjects, allowing students to undertake a broad-based programme. Consequently, central to their teaching practice was continual negotiation and debate with other natural science sub-disciplines, which reflected their different cognitive maps but also offered the potential to improve the curriculum.

What follows is an attempt to use Carper's framework to look at integrative patterns between discipline-specific pedagogies and the discipline of educational development that might lay the foundations for the future.

10.7 Empirical

The academics were in general agreement that natural sciences knowledge was systematically organised into general theories and laws that allowed for describing, explaining and predicting phenomena of interest to their discipline. Such explanations were governed by factual evidence, with the curriculum focusing on testing the validity and verifiability of such concepts. This is the empirical knowledge that informs curriculum development and delivery, and may be exemplified in the following quote:

> How do we acquire knowledge in the natural sciences? In biology we follow a process called the scientific method which enables us to gain information about the biological world. We observe, we develop a research question forming a hypothesis, collect information, record and analyse then form a conclusion… (Interviewee B)

However, within the natural sciences disciplines, the demarcation lines between are becoming less demarcated:

> I teach chemistry for Year 1 biology students and that is the main thing I teach…. (Interviewee D)

This in turn can lead to tensions over what needs to be taught and in what order, as this microbiologist explains:

> So we have a big fight actually in our department, because I want to put more maths in… (Interviewee C)

A reasonable amount of knowledge of peripheral disciplines is necessary, so curricular content is contextualised and applied in a meaningful way, especially if staff shortages mean that sometimes individuals have to teach their discipline across a number of sub-disciplines thus are required to be simultaneously both generalist and specialist:

> Last year we had to accommodate students from other programmes on this module for example, environmental science and it was hard to apply, it didn't quite make sense… (Interviewee B)

An example of how educational developers and natural science academics might collaborate and create some new knowledge was identified in the area of curriculum design:

> When I arrived I was asked to take a new programme in biochemistry to validation and I had to do this, but wasn't sure how to write learning outcomes at level 4… I understood there was particular language one had to use… also I would have liked to have used assessments which were different to the usual ones… It was very difficult. (Interviewee D)

Intuitional programme design tends to have its own empirical knowledge. Below is an example of how there can be the creation of a space between both, which is of reciprocal and mutual benefit:

> When we (B and the author) worked together developing the learning outcomes of the new biomedical degree, I felt between us we were able to create a living, breathing module narrative which was educational whilst true to the subject… (Interviewee B)

All four academics were experienced, committed researchers, and empirical knowledge was generated through such endeavours to a greater or lesser extent:

> Research is everything to me…. It stretches my mind and besides science is changing and I need to keep up to date. (Interviewee C)
>
> I enjoy research… I try to balance teaching responsibilities with research responsibilities so I try to stay up to date, publish two papers a year… this university is a teaching university so leaves me with very little time. (Interviewee D)

European guidelines, which position good teaching as an important constituent of good research essential for creating research environments with integrity:

> There is no contradiction between the imperative of good teaching and the imperative of research which critiques, refines, discards and advances human knowledge and understanding. Good teaching, in many subject areas, is only good if it is informed by the latest research. (European Commission, 2013: 13)

And educational development seeks to acknowledge this and to encourage academics to see an obvious relationship between the two dimensions of the role although, as can be seen from the second quote, with varying degrees of success.

10.8 Aesthetic Knowing

Carper warns of a danger that the only valid and reliable knowledge around teaching the natural sciences is that which is factual, objectively descriptive and generalisable. The aesthetic way of knowing can be viewed as a means of increasing agency for both educational developers and natural sciences academics. Whilst it is alive and well, as evidenced in the following example, it might be enhanced further:

> If you show them (the students) science really exists, that is their motivation... Stimulation is key… I provide them with the skills so they can see the outcomes. I think the key to good teaching is motivation… (Interviewee A)

The learning for educational developers is the need to adjust to the individual academic and their subject pedagogy, sometimes taking the lead from them:

> I tell students in lectures often not everything makes sense, but it will do in the seminar… (Interviewee B)

This and other forms of aesthetic knowing are collaborated by the others, especially the incremental approach, and just because a lecture has not been entirely accessible does not mean that it is a poor learning experience:

> I always reassure… I think it is mostly the support material afterwards which helps understand the lecture as no student will understand 100% of lecture. I say go back to the material… I include a lot of online resources. (Interviewee D)

There is potential for 'heuristic tools' co-created by educational developers and academics to offer a structure based on sound principles, and evidence-based practice for a particular activity, namely teaching observation, while allowing practitioners to adapt the heuristic tool in order to respond flexibly:

> Many of us in the natural sciences had trouble understanding educational language. We like fewer words and like bullet points… but when you showed us the Socrative app this was something we could use immediately in the classroom. It was quick, immediate and interactive. (Interviewee A)

Another example of how an educational theory helped academics is as follows:

> It was useful when you came to observe me teach a seminar on equations and we spoke for ages afterwards about what the threshold concepts and troublesome knowledge is in teaching equations. It helped me plan the session differently the next time, because I could preempt where students were getting stuck. (Interviewee C)

Seeing things from the student's point of view exemplifies the aesthetic way of knowing in its level of empathy and the tacit knowledge that academics rely on to inform their teaching:

> Every year students come after the first few weeks, they come to me saying they have never studied chemistry before, are going to fail and are terrified. I tell them they can pass the module with good grades, they just have to keep practising… (Interviewee A)

The academics all agreed that there are particular learning and teaching methods that are particularly appropriate for the natural sciences, and that these are the lecture, problem-based learning and practical work. The content may be empirical knowledge, but it can only be properly engaged with by students if aesthetic ways of knowing are attended to:

> I want to them to make the best link between lecture and lab and those students who do will get the best jobs… everything is connected. (Interviewee C)

Brew and Boud (1996, 2013) note the need for aesthetic approaches to educational development to 'respond to the professional or disciplinary context of academic work'. They recommend individualised pathways as well as bespoke initiatives that meet group or departmental needs, as advocated by Wenger et al. (2002). Such actions are characterised by a commitment to knowledge management, and values of openness and sharing ideas. Central to this approach is the notion that learning is intrinsic to human identity and that people learn best when actively involved.

10.9 Personal Knowing

Carper, when describing the ways of knowing framework, argued that achieving personal knowledge (knowledge of self) is challenging for practitioners, whilst also difficult to teach. Central to this is the importance of sitting with uncertainty and complexity.

> I don't feel comfortable talking about myself. I have my way of teaching and that's it. The quality of students who come here is lower than I am used to and I find it quite frustrating. Those who are interested in working harder I will help, but the others... well… (Interviewee A)
>
> It's funny that I now realise how my students feel. When we first met I didn't think I could learn anything from you and at first your questions made me feel defensive. Having you there in the lab and then talking about it afterwards was so helpful. It gave me confidence that I was doing a lot of good but might do even more. I realise it doesn't matter that you don't have a science background, because you get what I am saying to you really quickly because you listen carefully. It feels like a partnership… In that how can we put our different knowledge together to solve a problem… (Interviewee C)

Both quotes are illustrative of being out of their comfort zone and the emotions associated with teaching.

The following quote captures the creation of 'a new vision and a new lived experience…' (Nicolescu, 1999) and the ability to see things from different perspectives. What personal knowledge does is to legitimatise subjectivity and new perspectives on information. Educational developers do create undisciplined or interstitial spaces on the borders between disciplines that they then fill with new things. However, they can only do this in collaboration with subject specialists when there is dialogue and open discussion. So who or what helps with adaptation? This is where Carper is helpful by advocating the importance of reflexivity, empathy and openness:

> I really liked the session on responding to group dynamics and disengaged students. Considering the different scenarios and ways of dealing with them. I am now acting on your suggestions and am much better now at dealing with tricky situations with students whereas before I either ignored them or just didn't notice… I'm better at seeing it from their point of view. (Interviewee D)

10.10 Ethical Knowing

The recent government White Paper, 'Success as a knowledge economy: Teaching excellence, social mobility and student choice' (2016), states that students should expect a high quality of teaching.

All four academics loved their subject discipline and wanted to do the best for their students, despite limited resources. They suggest that they the fact that the university has accepted the student onto the programme means that they have an obligation to them, although sometimes this can be problematic:

> I feel strongly there should be a separate module in maths. They are weak in maths. Transforming equations is very weak, for example. I can't do that in a seminar. (Interviewee C)

What educational development can do is to allow space to lament the ambiguity and complexity that often surrounds the academic role, facilitating an understanding that moves beyond discipline and sees a bigger picture.

The natural sciences are an applied subject and it is uncontested that the best learning environment is the practicum and the role of the teacher is to create the conditions, as illustrated by the following quotes:

> This is not just about teaching it is about preparing them for work and the lab is the link to getting them a job… I watch the students and I think about job placements and working in industry immediately. (Interviewee C)

This same individual lamented the lack of resources that meant that he could only offer a few interested students additional lab time and an opportunity to work with him on projects. He was particularly proud of an initiative motivated by the morality of post-1992 universities degrees having less currency than research-intensive universities, especially when it came to the natural sciences:

> A bachelor degree at X university is not enough in itself to get them a good job… so I linked volunteering (in the lab) to the dissertation module… so they published papers with me… (Interviewee C)

One ethical area of knowing in this context in which academics and educational developers can come together is in the transparency and authenticity of assessment:

> What was great was when we looked at the design for the MCQ short-answer paper and drew up guidelines for the markers. Also facilitating our moderating meeting enabled us to come to some agreement… It's more fair now. (Interviewee D)

Two of the four interviewees had worked abroad in Northern Europe and the USA. They agreed that academics there have too much freedom in relation to assessment and the curriculum. What was missing were the checks and balances common to the UK, also the team-teaching elements that they very much appreciated as being fairer for students and less open to bias.

When it came to ethical ways of knowing, it was reported that, amongst the participants, professional development in this area is influenced less by formal courses and more by one's own experience as an academic, simply doing one's job, and non-formal interaction with colleagues. It was agreed that educational developers, provided that they understood the assessment structures and organisation of the lab, could have a role.

It was in pursuit of the unravelling of this complexity that the motivation for further research amongst and between the disciplines emerged. It would seem that, in engaging with others, observing, answering and asking questions, individuals find meaning through the exploration of my own mind and that of others. During this project the new knowledge has emerged from me examining my own practice, the personal testimony of others and observation, thus creating a different set of meanings. This is personal growth, as well as an evaluation of own practices and a deeper understanding of subject specific pedagogies. Those who fully engage in this

process are compelled to question their own assumptions and established ways of doing things.

The participants in this research, although situated in a particular discipline, are representative of the author's wider work as an educational developer. Those who participated have enabled her to extract meaning and actions from our work together that, in turn, will influence future transdisciplinary work.

It is clear that the academics interviewed did feel that educational developers might put up, rather than tear down, disciplinary barriers through the language that they used. There is a need to examine the accessibility of educational discourse and its linguistic complexity although, conversely, it could be argued that in the words of one of the academics who shared a common view expressed by others:

> They start to understand how it all works… but these concepts are not immediate and language is critical to a subject… It is a different way of thinking but if you keep practising you learn it in the end and understand. (Interviewee A)

It seems that the more engaged and open to transdisciplinary knowledge they are, in this context, the more 'ethical' academics and educational developers will be, and surely that should be enough to support such an approach.

10.11 Is Transdisciplinarity Work Political Work?

Political geographies in academic development and complexities, nuances and politics surround the role of an educational developer. It can be a role on the margin, hovering on the borders of other disciplines and departments. Educational development is political work, dependent on the building of trust, credibility and alliances when there is seen to be mutual benefit. UK higher education itself is currently undergoing extensive change, which impacts on all academics.

Educational developers have extensive knowledge about the scholarship of learning and teaching, but can still learn more about effective teaching practices within a subject discipline. In turn, subject specialists can work alongside educational developers to help to create best practice in teaching, learning and assessment. Based on the conversations between these four natural science academics and one educational developer, it seems important to move beyond neutrality and into the spaces in between disciplines.

Carper argued that as the shape and patterns of our ways of knowing are changed, it requires us to look for different points of contact and connection amongst ideas and things. This also happens with a transdisciplinarity approach, which itself can feel supportive and restorative in times of uncertainty and turmoil. Intrinsic to the epistemology of this undertaking is how collegiality, communication and the creation of communities of practice might inform future work between educational developers and other disciplines. Preliminary insights reveal that this is new knowledge ready to be critically analysed and synthesised.

10.12 Summary

This chapter has raised a series of theoretical questions:

- What does transdisciplinarity mean for educational developers and those they work with?
- How might future research be critically evaluated?
- Where is the potential for creating opportunities for future research, exploring the teaching of natural sciences in higher education and the scholarship of educational development?
- How might the academy support the agency of natural sciences academics to embrace the notion of transdisciplinary?

Reflective practice in higher education is the key to transdisciplinary practice and increased resilience in battling with multiple demands. Rowland (2000) is a long-standing advocate for creating space for lecturers in higher education to come together and develop pedagogical models informed by their daily teaching practices. He passionately argues for a dynamic relationship between public knowledge and personal knowledge that comes from practitioners communicating together and building theories. For the author, a cornerstone of practice has always been advocating that such scholarly conversations, when real and relevant, increase practitioners' confidence and can have immense impact.

Carper and her ways of knowing offer a way of framing and presenting a theoretical argument, including what reflexivity is needed and an opportunity to explore the influence of disciplinary cultures on academics teaching beliefs and practices. It provides a theoretical lens and leads to the suggestion of the value of a conceptual model of transdisciplinary to enhance students' reflexive skills. This constitutes the first steps towards transdisciplinarity and an acknowledgment that context matters.

The learning for educational developers is the need to adjust to individual academics and their subject pedagogy whilst retaining our own disciplinary knowledge, laying the potential for better understanding and new knowledge. Important is the need to examine how formal teaching and learning programmes, facilitated opportunities and spontaneous encounters might draw on varied disciplinary backgrounds and experience to enhance transdisciplinary practice still further.

10.13 Conclusion

This collaboration between early career natural science academics and an educational developer has enabled meaning and actions to be extracted from joint work that, in turn, will influence understanding of transdisciplinarity practices. It suggests that transdisciplinarity offers the potential for a richer approach to teaching and learning that could also contribute to higher education's transformation.

Giving critical attention to what it is to know and what kinds of knowledge is held to be of most value, deconstructing the opposition to different patterns of thinking. The knowledge that might be created by exploring and working within the 'empty spaces' between a subject-specific discipline and educational development has been transformative. To make it generative, meaningful and influential, a way forward is to link this work to the concept of discipline-based educational developers.

Higher education, according to Budge and Clarke (2012), requires the development of inspiring educators who have the capacity to respond creatively to complex learning environments. Arguably, educational development needs, therefore, to support and motivate faculty within such rapidly changing landscapes through the active exploration of transdisciplinary approaches.

A greater exploration of transdisciplinary practice between educational developers and academics in specific disciplines could help to transcend these 'empty spaces' and create a foundation that 'enables us to name its components and see how they fit together as a whole and as a foundation on which to grow and deepen the practice' (Marshall, 2015: 6).

This case study focused on academics in the natural sciences, but Carper's framework lends itself easily to a range of disciplines, allowing for flexibility and pedagogical nuance. 'Can you help me to understand your discipline?' remains one of the most important questions that individuals can ask when working in this way with others. In the context of educational practice, it allows us to participate in open discussion, address complex problems and improve the student experience.

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Part III
Issues Relating to Transdisciplinarity

Chapter 11
Technological Singularity: The Dark Side

Basarab Nicolescu

The *technological singularity* is defined as a hypothetical event in which artificial intelligence would be capable of recursive self-improvement or of autonomously building smarter and more powerful machines than itself, up to the point of an *intelligence explosion*, that yields an intelligence surpassing all current human control or understanding. Because the capabilities of such superintelligence may be impossible for humans to comprehend, the technological singularity is the point beyond which events may become unpredictable. One speaks about an *essential singularity in the history of the human race beyond which human affairs, as we know them, could not continue.*[1]

Nicolas de Condorcet (1743–1794), the eighteenth-century French mathematician, philosopher and revolutionary, is commonly credited for being one of the earliest persons to contend the existence of a singularity. In his 1794 *Sketch for a Historical Picture of the Progress of the Human Mind,* Condorcet states: 'Nature has set no term to the perfection of human faculties; that the perfectibility of man is truly indefinite; and that the progress of this perfectibility, from now onwards independent of any power that might wish to halt it, has no other limit than the duration of the globe upon which nature has cast us.'

The term 'technological singularity' was originally coined by the mathematician, computer scientist and science fiction author Vernor Vinge, who argues that artificial intelligence, human biological enhancement, or brain–computer interfaces could be possible causes of the singularity. Futurist Ray Kurzweil predicts the singularity to occur around 2045, whereas Vinge predicts sometime around 2030.

Vinge predicted four ways that the singularity could occur:

[1] Max More & Natacha Vita-More (eds), *The Transhumanist Reader – Classical and contemporary essays on the science, technology, and philosophy of the human future.* Wiley-Blackwell, John Wiley & Sons, West Sussex, 2013.

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1. The development of computers which are 'awake' and superhumanly intelligent.
2. Large computer networks (and their associated users) may 'wake up' as a superhumanly intelligent entity.
3. Computer/human interfaces may become so intimate that users may reasonably be considered superhumanly intelligent.
4. Biological science may find ways to improve upon the natural human intellect.

The basic idea is that, although technological progress has been accelerating, it has been limited by the basic intelligence of the human brain, which has not changed significantly for millennia. Many writers tie the singularity to observations of exponential growth in various technologies, using such observations as a basis for predicting that the singularity is likely to happen sometime within our century.

Between 1986 and 2007, machines' application-specific capacity to compute information has roughly doubled every 14 months; the capacity of the world's general-purpose computers has doubled every 18 months; the global telecommunication capacity doubled every 34 months; and the world's storage capacity doubled every 40 months. Like other authors, though, Kurzweil reserves the term 'singularity' for a rapid increase in intelligence (as opposed to other technologies), writing, for example, that 'The Singularity will allow us to transcend these limitations of our biological bodies and brains… There will be no post-Singularity distinction, between human and machine'. He believes that the 'design of the human brain, while not simple, is nonetheless a billion times simpler than it appears, due to massive redundancy'. He defines his predicted date of the singularity in terms of when he expects computer-based intelligences to significantly exceed the total sum of human brainpower. Kurzweil's analysis of history concludes that technological progress follows a pattern of exponential growth, following what he calls the 'Law of Accelerating Returns'. Whenever technology approaches a barrier, Kurzweil writes, new technologies will surmount it.

In 2009, Kurzweil and Peter Diamandis announced the establishment of 'Singularity University', whose stated mission is 'to educate, inspire and empower leaders to apply exponential technologies to address humanity's grand challenges.' Funded by Google, Autodesk, ePlanet Ventures and a group of technology industry leaders, Singularity University is based at NASA's Ames Research Center in Mountain View, California.

In his 2005 book, *The Singularity is Near*, Kurzweil suggests that medical advances would allow people to protect their bodies from the effects of aging, making the life expectancy limitless. Kurzweil argues that the technological advances in medicine would allow us to continuously repair and replace defective components in our bodies, prolonging life to an undetermined age. Kurzweil further buttresses his argument by discussing current bioengineering advances. Kurzweil analysed Somatic Gene Therapy (SGT), which is where scientists attempt to infect patients with modified viruses with the goal of altering the DNA in cells that lead to degenerative diseases and aging. Celera Genomics, a company focused on creating genetic sequencing technology, has already fulfilled the task of creating synthetic viruses

with specific genetic information. The next step would be to apply this technology to gene therapy. Kurzweil's point is that SGT provides the best example of how immortality is achievable by replacing our DNA with synthesised genes.

Computer scientist, Jaron Lanier, writes, 'The Singularity [involves] people dying in the flesh and being uploaded into a computer and remaining conscious'. The essence of Lanier's argument is that in order to keep living, even after death, we would need to abandon our physical bodies and have our minds programmed into a virtual reality.

Strong artificial intelligence can also be idealised as 'a matter of faith', and Ray Kurzweil thinks that the creation of a deity may be the possible outcome of the singularity.

The huge literature around the concept of the technological singularity puts the accent on the bright, attractive and utopian side of technology. In my chapter, I choose to speak about its dark side.

From the numerous books, articles and internet documents, I conclude that all this talking about 'the technological singularity' is not rigorous. Science fiction is not science and wishful thinking is not serious thinking. In fact, the technological singularity is not a singularity in a mathematical meaning of this word. Exponential behaviour does not mean singularity. All that, in my view, appears to be an excuse to dissimulate the basic ideology behind all that: the advent of *transhumans*. 'Singularity' is used like a metaphor to suggest the jump from humans to transhumans. In another words, the technological singularity is the basic ground of what is called *transhumanism*.

Let me make, based upon the transdisciplinary approach, some short considerations about transhumanism.

If the transhumanist project will be achieved, human beings will become increasingly more a machine and the machine will become increasingly more human. The international cultural and intellectual movement of transhumanism advocates the use of biotechnology to improve physical and mental characteristics of human beings. Aging and death are considered undesirable and should not be inevitable.

Natural selection is considered to be outdated and it is replaced by technological selection. The major project is to remove any transcendent force and replace it with man-machine with superhuman intelligence, master of his/her life. Transhumans, which some philosophers and ideologists call them, for obvious oratorical precautions, 'improved humans' or 'ameliorated humans', will constitute a new, biotechnological species. Future society will be divided between 'transhumans' and 'old humans'. The old humans will inevitably be servants of the transhumans.

It is remarkable that Sigmund Freud predicted the emergence of transhumanism already in 1930, in his book *Das Unbehagen in der Kultur/Civilization and Its Discontents*. He spoke of the desire of human beings to be equal to God, becoming a *God-prosthesis*. This process is achieved thanks to the second nature of humans, the technological nature, allowing them to dominate the world.[2]

[2] Sigmund Freud, *Le malaise dans la culture*, Flammarion, Paris, 2010.

From my point of view, we live in a time of a new barbarism which might be characterised by three words: transhumanism, panterrorism and anthropocene.

I introduce the neologism *panterrorism* – to describe a new form of terrorism, without any real connection with a religion. Its aim is to kill the other in order to impose its own power. On 13 November 2015, Paris was hit by blind force of hate. It was a massacre of innocents. What was intended was to kill a certain way of life, whose symbol is Paris. In this new form of terrorism, there is no a soldier in front of another soldier. There are only killers who blindly exterminate an anonymous mass. The panterrorism, more and more present on our planet, is replacing God with the human being. By killing the other, the desire of omnipotence reaches an unpredicted climax. The French philosopher Marcel Gauchet noted in a recent conference that jihadism is a disconcerting phenomenon. Jihadism is, after the fall of the Nazi and Communist totalitarianism, a new form of totalitarianism that uses religion as a political project.[3] This new form of totalitarianism will inevitably use the new technologies – including 3D printing in order to produce arms and bombs, Internet of Things (IoT) in order to commit mass crimes, electronic chips implanted in the human body in order to dispose of a fabulous quantity of information, and so on.

11.1 The Technological Singularity Is Blind to Human Values

The word *anthropocen*e is a neologism designating a new geological era, characterised by the fact that the actions of human species become the dominant geophysical force of our planet as compared with natural geological forces. There is a danger today, for the first time in history, concerning the extinction of the entire human species.[4] The survival of the human species is, for a good number of scientists and philosophers, the most important issue of our time.

As the well-known Australian climatologist Clive Hamilton writes in his book *Requiem for a Species,*[5] it is difficult to accept the idea that human beings can change the composition of Earth's atmosphere at a point of destroying their own civilisation and also the human species. One can predict sea level rise of several metres during this century and the dissolution of the Arctic sea ice in one or two decades. One can even predict that the ice on the entire planet will disappear in

[3] Marcel Gauchet, 'L'attraction fondamentaliste', talk at the workshop 'La psychanalyse et le fait religieux' organized by Association 'Espace analytique', Campus des Cordeliers, Paris, 19 March 2016.

[4] See, for example, Bruno Latour, L'Anthropocène et la destruction de l'image du Globe', in Emilie Hache (ed.), *De l'univers clos au monde infini*, Paris: Éditions Dehors, 2014: 27–54.

[5] Clive Hamilton, *Requiem pour l'espèce humaine – Faire face à la réalité du changement climatique*, Paris: Presses de la Fondation Nationale des Sciences Politiques, 2013, trans. to French by Françoise Gicquel and Jacques Treiner. Original edn: Clive Hamilton, *Requiem for a Species – Why we resist the truth about climate change*, London: Earthscan, 2010.

several centuries, leading to rising sea levels by about 70 m. Unexpected phenomena will occur: domestic animals will turn into wild animals and grown plants will disappear.[6] The consequences on the security of nations will be huge: waves of refugees from climate-disadvantaged countries will emigrate to climate-favoured countries, which will cause unprecedented conflicts. International organisations are not prepared to face such a situation: they are not concerned with the security of the planet.

The prospect of a chaotic climate change shows the failure of certainty, which was born at the Enlightenment period. The modernity project is seriously questioned.

One thing is certain: in the Anthropocene, the old and persistent radical distinction between nature and culture is no longer valid. Culture changes nature. Desecration of nature thus reaches its peak.

How can this terrible catastrophe be avoided? In the US, politicians are convinced that it can be avoided by technological solutions, and the authorities have formed several committees of specialists to find such solutions. A new discipline was born, very prosperous today: geo-engineering, whose object is manipulating the environment to counterbalance the climate change caused by the human species. The goal is to transform the chemical composition of the atmosphere so that one can adjust at will the temperature of our planet.

Paul Cruzen, Nobel Prize of Chemistry, proposed in 2006 to introduce aerosols into the atmosphere to reflect sunlight.[7] This suggestion has opened a strong research track, supported by prestigious institutions such as the US National Academy of Sciences and the Royal Society. The idea is to inject dioxide of sulfide into the stratosphere, in gaseous form, at an altitude of 10–50 km, forming in such a way of sulfate aerosol, particles that can reflect sunlight.[8] Paul Cruzen remarks in passing that the diurnal sky will become permanently white, a grim perspective on the aesthetic level. It is amazing that scientists of the stature of Edward Teller (co-founder and director of Lawrence Livermore National Laboratory in San Francisco) and Lowell Wood (researcher at the same laboratory and influential scholar at Pentagon) are among the staunch followers of this technological solution. With a huge vanity, Lowell Wood said in all innocence: 'We turned all the surrounding environments. Why do not we do the same with our planet?', an assertion which is, in fact, a transhumanist assertion.

From my point of view, in agreement with Clive Hamilton, it is not technology that will save our species, but a radical change of our vision of reality.

It is evident that to meet this triple threat – transhumanism, panterrorism and Anthropocene – it is necessary to develop a strong, rigorous, universal and visionary thinking. Just humanistic claims are totally inefficient.

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[6] *Idem*: 44.

[7] Paul Cruzen, Albedo enhancement by stratosferic sulphur injections: A contribution to resolve a policy dilemma, *Climatic Change,* 77 (3–4): 211–220.

[8] Clive Hamilton, *Requiem for a Species*, op. cit., p. 198.

In this chapter, I want to formulate the hypothesis that the transdisciplinary interaction of philosophy and spirituality with other sciences, exact and human, is the privileged means of resistance to the new barbarism. I call *transdisciplinary philosophy* the philosophy which integrates the transdisciplinary methodology.

There is a big spiritual poverty present on our Earth. It manifests as fear, violence, hate and dogmatism. In a world with more than 8000 academic disciplines, more than 10,000 religions and religious movements, and more than 6000 tongues, it is difficult to dream about mutual understanding and peace. There is a need for a new spirituality, conciliating technoscience and wisdom.

The first motivation for a new spirituality is technoscience, associated with fabulous economic power, which is simply incompatible with present spiritualities. It drives a hugely irrational force of efficiency for efficiency's sake: everything which can be done will be done, for the worst or the best. The second motivation for a new spirituality is the difficulty of the dialogue between different spiritualities, which often appear as antagonistic, as one can testify to in our everyday life.

Simply put, we need to find *a spiritual dimension of democracy*. Social and political life goes well beyond academic disciplines, but they are based upon the knowledge generated by them.

Homo religiosus probably existed from the beginnings of the human species, at the moment when the human being tried to understand the meaning of our life. The *sacred* is our natural realm. We tried to capture the unseen from our observation of the visible world. Our language is that of the imaginary, trying to penetrate higher levels of Reality – parables, symbols, myths, legends, revelation.

Homo economicus is a creation of modernity. We believe only in what is seen, observed, measured. The *profane* is our natural realm. Our language is that of just one level of Reality, accessible through the analytic mind – hard and soft sciences, technology, theories and ideologies, mathematics, informatics.

The only way to avoid the dead end of the *Homo religiosus vs. Homo economicus* debate is to adopt *transdisciplinary hermeneutics.*[9] Transdisciplinary hermeneutics is a natural outcome of transdisciplinary methodology.

In this context, I want to recall a crucial feature of transdisciplinarity – the Hidden Third – that I introduced in my work.[10]

The zone of non-resistance, in between and beyond levels of Reality, plays the role of a *third* between the Subject and the Object, an Interaction term which allows the unification of the transdisciplinary Subject and the transdisciplinary Object, while preserving their difference. This Interaction term is called the *Hidden Third.* The Subject and the Object are immersed in the Hidden Third.

The Hidden Third, in its relationship with the levels of Reality, is fundamental to the understanding of *unus mundus* described by cosmodernity. Reality is simultaneously a single and a multiple One. If one remains confined to the Hidden Third, then

[9] Basarab Nicolescu, Transdisciplinarity as a methodological framework for going beyond the science and religion debate, *Transdisciplinarity in Science and Religion* 2 (2007): 35–60.

[10] Basarab Nicolescu, *From Modernity to Cosmodernity – Science, culture, and spirituality*, State University of New York (SUNY) Press, New York, 2014.

the unity is undifferentiated, symmetric, situated in the *non-time.* If one remains confined to the levels of Reality, there are only differences, asymmetries, located in time. To simultaneously consider the levels of Reality and the Hidden Third introduces a breaking in the symmetry of *unus mundus*. In fact, *the levels of Reality are generated precisely by this breaking of symmetry introduced by time.*

In the transdisciplinary approach, the Hidden Third appears as the source of knowledge but, in its turn, needs the Subject in order to know the world: the Subject, the Object and the Hidden Third are interrelated.

The human person appears as an interface between the Hidden Third and the world. The erasing of the Hidden Third in knowledge signifies a one-dimensional human being, reduced to its cells, neurons, quarks, elementary particles and electronic chips.

The Hidden Third between Subject and Object is rational, but it denies any rationalisation. Therefore, Reality is also *trans-rational*.

A new spirituality, free of dogmas, is already potentially present on our planet. There are exemplary signs and arguments for its birth, from quantum physics till theatre, literature and art.[11] We are at the threshold of a true New Renaissance, which asks for a new, cosmodern consciousness. But, paradoxically, the new Renaissance potentiality is overshadowed by the violence of the new barbarism, which is a new phase of the confrontation between *Homo economicus* and *Homo religiosus.*

Etymologically, the word 'barbarian' means one who is a stranger – an alien who belongs to an uncivilised world. In this context, new barbarism introduces a radical newness, for it means that the alien is not outside us, but within us. We are our own barbarians. There is an *ontological barbarism* consisting in the desire to reduce everything to a single level of Reality, a *logic barbarism* consisting in the refusal of any other logic than that of the excluded third, and an *epistemological barbarism* consisting in the refusal of complexity, of the interconnection between different levels of Reality.

The three tentacles of the new barbarism – transhumanism, panterrorism and anthropocene – are a result of this triple barbarism – ontological, logical and epistemological. They have in common the assassination attempt of the Hidden Third. Therefore, transdisciplinary philosophy, which gives a profound meaning to the Hidden Third, is the privileged means of resistance to the new barbarism and it could educate the young generations in the spirit of this resistance.

[11] Basarab Nicolescu, *From Modernity to Cosmodernity – Science, culture, and spirituality*, op. cit.

Chapter 12
Transdisciplinarity as a Global Anthropology of Learning

Kate Maguire

In his opening page of his textbook, *What is Anthropology* (2009), Eriksen draws on the wisdom of two great minds over a century apart: 'Make everything as simple as possible. But not simpler' (Einstein); 'He who speaks no foreign language knows nothing of his own' (Goethe). In doing so, he captures two attitudinal tenets fundamental to the practice of anthropology: the *emic* principle and the *etic* principle. The emic principle is a non-judgmental approach to observing and entering the context of the 'other', not with the researcher-focused intention of understanding what is going on, but of clarifying the understanding that the member of the culture has about their own context, their artefacts, rituals and practices, how relationships are formed and meaning sustained through what constitutes that context. The observations of the other are not skewed by the anthropologist's own lens. What is reported simply at first appears simple, but is not. The *etic* principle can be summed up as a function of what is learned from a new 'culture' is to question the understanding of the 'culture' from which the anthropologist has arrived. The new understanding that emerges in these bridging spaces between difference thereby contributes to knowledge of the universality of human behaviour.

These two tenets, from seafarers and traders, to anthropologists and archaeologists with a curiosity to learn about what exists outside their own experience, have shown themselves to be sound approaches both to contributing to and navigating complexity. I suggest that anthropology has much to offer our contemporary occupations with cohesion in a global context. This chapter focuses on two cultures of knowledge: the culture of the university, which has over the past 200 years held claim to discipline-specific theoretical knowledge based on rigorous research, and organisations outside of the university that have claim to practitioner/experiential knowledge across a range of disciplines and sectors. In recent years, much like colonial influences on discrete islands, market forces have challenged the culture of

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the university and its place in the new order. In this chapter I will draw on the experience of working with senior professionals who come into higher education to develop research skills that will enable them to bring about 'change' in work practices and organisational cultures outside of higher education.

To gather proofs or evidence of the reliability of meaning making out of what one perceives, one theorises and hypothesises using existing data. However, theorising is predicated on being able to conceptualise that which is the focus of the examination. Conceptualising practices in cultures outside the university is a challenge that confronts university facilitators of research. It takes place within those cultures but under university guidance, rituals and practices that differ from those in the location of the research. The flourishing of such cultures external to the university is premised on fast connectivity to knowledge and knowledge application, to markets and to people in ever-changing environments. This connectivity is scaffolded by the interconnectivity of diverse cultural practices, both internal and external to each culture.

Drawing on Bateson's notion of the ecology of the mind (1973) – that is, that ecosystems engage in adaptive processes – cultural ecologies that sit outside of higher education institutes yet also surround them and recruit from them have developed the capacity to engage with adaptive processes. They have done so in a way that is more rapid, complex, agile and dynamic than the cultural ecology of a university, with both positive and negative consequences. It is not enough for universities to engage theoretically with the notion of connectivity to external ecologies, as if they are constantly viewing at a distance. They should actively contribute to the input that causes the culture to adapt and to the processes of that adaptation, and revise and increase their own adaptive processes and rate of response. Such cooperation can enhance the chances of any change achieving benefit for the many rather than the few.

In this chapter, encouraged by the work of Hasse (2015) and Boulton, Allen, and Bowman (2015), I am proposing a conceptualisation of learning as a way of understanding complexity and as an attitude towards it, to clarify how higher education can to contribute to the flow, direction and dynamism of interconnectivity. This conceptualisation pulls together Hasse's notion of an anthropology of learning and discourses on transdisciplinarity and complexity, arriving at transdisciplinarity as a global anthropology of learning. To facilitate movement then, from conceptualisation to practical application through new researchers, I will also be proposing a recontextualisation of the notion of a 'teacher' tasked with the skilling of the agent/agents of 'change' in this new world of complexity, drawing on ideas from anthropology, translation studies and hermeneutics.

12.1 The Context of Knowing from Practice

If higher education is to negotiate seriously for an influential role in the global superorganism that represents our world today, it has to embrace the reality of knowledges – not as islands, but as 'knowing' that emerges from the interconnectedness of practices in relationship to objects and the making sense of practices in time, space and place. This is, in other words, what emerges from the interplay of structure and processes. Nicolini's view that 'claiming the world we live in is the result of practices does not make it less "solid" or "relative"' (2013: 3) is a challenge for those who believe that truth, reality and knowledge have to lend themselves to being numerically measured, rather than assessed by judgment and independent thought, before they can be acted upon. There is the seduction of believing that if we share the same technological devices to engage with each other in knowledge exchange then, in effect, we are speaking the same language and can reduce everything to measurement. Technologies are not new. Digital technologies have precursors in cooking pots, musical instruments and stones grinding grain. In this context, Hasse (2015) reminds us that technological artefacts are:

> not stable cultural resources that retain their word meaning when they travel through the world, when they move between cultural spaces… People learn about the meanings of artefacts when they handle them in their own practice-based learning in local activities… People working together with the same kinds of artefacts develop similar agential knowing, and they also learn from the artefacts in ways that expand their being-in-the-world. (2015: 280)

In other words, it is not the artefact itself but its flexibility, how it is used and for what purpose that disrupts or reinforces the meaning-making relationships of our formative or adopted culture and stimulates adaptive responses. The adaptive capacity to respond appropriately is the life source of an organism. As every anthropologist knows, and as Nicolini highlights (2013: 3), practices are 'also very resilient and often difficult to change because, qua practices, they are taken for granted and often considered as part of the "natural" order of things'. An anthropological view would say that these practices have become ritualised, in some cases to the extent that few can remember in what context they arose, for what purpose and why have been sustained over time. Their status has become 'sacred' or untouchable and unquestioned. Such 'sacred', ritualised practices contribute to the atrophy of an organism, including the practices and attitudes of discipline silos in higher education. For Nicolini, however, 'Practice theories are inherently relational and see the world as a seamless assemblage, nexus, or confederation of practices – although not all having the same relevance' (2013: 3). For Hasse, 'A practiced place is a habitat where materials and meanings continuously emerge and affect the cultural ecology' (2015: 12). The stimuli of that emergence, or indeed its inhibitors, are both internal and external, and identifying the inhibitors and encouraging the emergence in each context are areas to which researchers and facilitators of research can give more focused attention, as the thriving of an organism in itself and within a wider global network depends on it.

Technology, therefore, is an artefact: an object that can be a device for learning and communication and can have an impact on cultural practices within and between different cultural hegemonies. Technology can facilitate information exchange, but the differential in adaptive processes within and between cultures can create greater discontinuity between them and inhibit transformative changes beyond the *emic–etic* tension. The drive to respond to this rapid increase in connectivity has offered fertile ground for conceptualisations of complexity to assist our navigation and facilitation of the knowledge flow between these different cultural entities and their practices, and draw us to attend to the capacity building of adaptive processing systems.

12.2 Adaptive Capacities and Complexity

Boulton et al. (2015), by entitling their publication *Embracing Complexity,* have confronted the trend for discourses on *managing complexity* that are usually accompanied by an array of bureaucratic systems to achieve that.

> Complexity emphasizes and incorporates the interconnected, interpenetrating, diverse, and sometimes diffuse qualities of most natural and social systems. This is a so-called 'ontological stance', a view of how the world works. We are describing the nature of things as systemic, complex, and affected by the particularity of the situations we are in and by the particularity of history. (2015: 35)

Rather than trying to control and marshal what is and is not knowledge, this concentration on the interconnectedness of things and on 'particularity' as a key component of understanding how complexity operates, strongly echoes the thinking of twentieth-century anthropologists who profoundly changed what the West considered as constituting knowledge by supplying extensive data on diversity that could not be ignored. It took several more years to rescue anthropological case studies from the realm of 'peculiarity', where they had been relegated, to the realm of 'particularity', where they rightfully belong. As will be seen further on, transdisciplinarity shares this 'so-called ontological stance', more commonly referring to 'particularity' as 'contextuality'. Ecological systems all have their own particularities that impact their capacities to adapt and, without adaptation, the ecology can atrophy. Therefore, the search for resilience of the organism or cultural ecology has become as feverish and mythical as the search for Parsifal's holy grail, the shaman's for enlightenment or the legendary hero for what will save his people. Managing complexity seeks total stability and certainty, which will render the system stagnant. It is motivated, to a large extent, by fear of uncertainty; embracing complexity recognises the fluid nature of the interaction of things, the opportunities presented by uncertainty and the importance of the health of the adaptive capacities of the entity. For Allen (1997: 17, in Boulton et al., 2015: 39), resilience and the capacity to adapt are interrelated:

> The capacity to adapt and respond to external and internal variation, although requiring some 'instability' can be the origin of the system's resilience. This is an example of the complexity of some of these issues in which adaptability may allow stasis in a broader sense, and rigidity may lead to collapse.

Boulton et al. (2015: 39) propose that adaptability and resilience in fact 'require diversity, variation and fluctuations'. Drawing on Allen's publication in 2001, they provide an enriched description of adaptive capacity.

> Allen (2001) describes the need for this redundancy (that is, having more options or pathways that are necessary to function like a machine) as the law of excess *diversity*. He is saying that, unless there are more pathways or options (called *degrees of freedom* by mathematicians) than are required to operate efficiently, there is no resilience to changing circumstances. However much diversity seems requisite (Ashby, 1956) for a system to function at a given time, more than this will be required to cope with what is likely to happen in the future.

Twentieth-century anthropologists were witness to the rapid erosion of cultural ecologies through external factors that overwhelmed their historically embedded systems. These systems had been sustained for centuries through rituals and practices, through a relationship with temporality that we do not have today and a minimum of contact with external factors. Anthropologists delved into a number of disciplines, including ecology and psychology, to increase their understanding of the processes of the rise, maintenance and decline of a cultural system. Institutes of higher education are cultural ecologies, as are other organisations and societies of practice, wherever they are located on the planet, with their own particularities and differing adaptive capacities. Part of the function of an institute of higher education is, in a sense, to be an anthropologist of other cultural ecologies, to reflect on what it finds and to contextualise it in the accumulated knowledge it holds in a range of disciplines. However, it too is subject to external factors and vulnerable to stagnation and atrophy if the knowledge that it holds and the rituals that it requires are no longer relevant to the conditions in which other ecologies sit and function. The higher education institute needs to adapt, and to do that requires it to become more closely connected to other ecologies.

Conceptualising the world as complex helps us to explore it more usefully and to theorise it more reliably so that our contributions have both an intrinsic and extrinsic value to the whole superorganism and those who populate it. I would argue that embracing complexity is an attitude to knowledge and to the world that resonates deeply with that of transdisciplinarity and anthropology.

12.3 Transdisciplinarity and Anthropology

I am influenced in my thinking about TD by my formative 'discipline', which is indeed anthropology, and enjoy the anthropologist Catherine Hasse's view (2015) that research is an anthropology of learning and that TD is, in itself, both a means and a metaphor for connectivity through the 'dissolving' of obstacles to knowledge and knowing (Somerville & Rapport, 2002).

I am interested in its facility as a conceptualisation of practice that informs the methodology of the anthropology of global learning about cultural ecologies. The eminent anthropologist Gregory Bateson (1973) who, with Margaret Mead, observed and recorded Pacific cultures over long periods of time, proposed the idea of ecologies in which space, place, temporality, the animate and inanimate give rise to adaptive practices and formations of identity. Julian Steward is credited with coining the phrase 'cultural ecologies' in 1955 (Steward, 1972) and Finke (2013) has advanced Bateson's and Steward's ideas in his work on transdisciplinarity. Manderson (2000), an Australian legal scholar, writes of transdisciplinarity as an anthropologist might when he states that TD 'examines a particular site or sites of interest without a particular disciplinary strategy in mind. It is the site as observed and not the intellectual tradition of the observer which determines the approach' (2000: 87) I agree with him that areas such as 'city' or 'drugs' provide places of conjunction between such a variety of disciplinary issues that no disciplinary or interdisciplinary framework can do justice; rather; it is only by treating every discipline as relevant but never a hegemonic structure that an understanding of the structure, function and meaning of the ecology of that site can begin to be understood.

TD has proved to be a contested term: it is an approach to knowledge; it is another iteration of action research; it is a response to complexity; it will save the planet; it dismisses disciplines; it unites disciplines; it is beyond disciplines; it is a collaborative research approach. Such discourses on the one hand move us towards clearer thinking and criteria. On the other hand, an increasingly refined distillation can shift TD closer to prescription and restriction, new rituals for old and the antithesis of the source of its emergence, or rather its re-emergence. Transdisciplinarity, conceptualised as working across ethnic and knowledge cultures in order to illuminate and change our own, is fundamental to twentieth-century anthropology (Maguire, 2015a; Mead, 2004; Levi-Strauss, 1974). It can also be seen as an attempt to reconnect a range of knowledges which were split off into discipline islands by the rapid advance of science in the late nineteenth century, a development that Foucault (1995) saw as the antithesis of knowledge. As a research approach, it is identified with groups working collaboratively to solve complex problems in which the focus is on the collaboration of thinking and ideas between different work and knowledge cultures, rather than, as in some forms of action research, the focus being on the development of the practitioner through facilitating learning loops for a specific work culture to solve problems within the culture. Manderson (2000: 87) offers this useful translation of what TD is and what it does.

> Creates new objects of study by examining the themes or aspects which different disciplines have in common and therefore assume without interrogation. Transdisciplinarity is to disciplines as metaphysics is to physics; transdisciplinarity is to disciplines as factors are to numbers… Examines a particular site or sites of interest without a particular disciplinary strategy in mind… Treats different disciplines as verbs rather than nouns. Different disciplines (or ways of approaching a subject) are not reified, but are treated as being active in each other…

TD continues to struggle with academic validity in some academic quarters, because it most commonly defines itself as an approach to knowledge, rather than a discipline. This claim of 'an approach to knowledge' would not have been possible for social/cultural anthropology in the twentieth century although, I would suggest, it more accurately describes its intentions and methodology. It needed to be part of the higher education context of the discipline paradigm or it would have been marginalised as a hobby for eccentric individuals interested in exotica. Franz Boas, regarded as the founder of social anthropology and mentor of Margaret Mead, did much to establish social anthropology as a discipline. However, Mead herself was often questioned as to her credentials as an academic, and the field of cultural/social anthropology was challenged as a credible discipline (Maguire, 2015a; Price, 2004). Anthropologists, as ethnographers, developed approaches to understanding human behaviour through long immersion in societies, and critical reflection on their observations and encounters. As ethnologists, they drew together numerous accounts in order to have something useful to say on the universals of human behaviour and what came to be termed the human condition. Anthropologists brought back ideas to Europe and America that unsettled, in a substantial way, the foundations of political and social hegemonies that were the justification for a range of exclusions including gender, race and mental health. Fear of the attitudes that many anthropologists held towards difference and of their advocacy to respect the cultures of others was enough to have several American anthropologists during the Cold War arrested, lose tenure as academics and put under suspicion of being anti-American (Price, 2004).

Similarly, TD has emerged with an attitude of positive, non-judgmental engagement with our world. It is focused on bringing that attitude to bear on tackling the big problems, such as climate change, diminishing resources, forced migrations and wealth imbalance, and to underpin research's social responsibility by ensuring inclusion of the perspectives and knowledge of the non-discipline subject specialists who represent the people and practitioners inhabiting those spaces. In terms of global warming and the threat of tsunamis, for example, that would be those who occupy and make a living from the littoral spaces of the planet: the fishermen, community leaders and builders, in addition to climatologists, geologists, meteorologists, public health specialists and others with vested interests.

TD challenges our traditional relationship to the theoretical object of disciplines, creating the conditions for a different kind of learning and knowledge to emerge. Transdisciplinarity, in its intention, seeks knowledge that does not emerge from ontological and epistemological narcissism, and an application that intends a more even distribution of the benefits of the solution. In this sense, it is a finer iteration of anthropology. Ethnographers, on the whole, did not actively seek to divest themselves of the formulations and theoretical lenses shaped by their own cultures but, through the relational process with this new 'object' of 'the other', the vast contradictions that arose led to new learning and perspectives which they disseminated.

12.4 Learning What Matters: Recontextualising: Researcher as Ethnographer, Teacher as Translator

We work in the cultural ecology of a university to develop researchers in practice in cultural ecologies outside of the university, where the language is one of sectors, agencies, units and departments rather than disciplines, and the rituals are diverse and embedded, yet subject to sudden change. The agency of the practitioner in these spaces is not as an advocate of a single-discipline culture. Modern practitioners today consistently interact with a multitude of practices that are in constant adaptive processes with each other within their cultural ecology and influenced by the practices and outcomes of external cultural ecologies. In such an environment, a complex problem may be identified that could destabilise the existing ecology. Thus, the everyday objective of any ecology is to keep all the internal parts connected as a stable base for internal and external exchanges to take place that might enable a wider and more informed lens on what may turn out to be a re-identification of the problem. Such a re-identification requires a recontextualisation of the issue and the development of a set of new practices as an adaptive response. Obstacles to that process may include sacred rituals and beliefs that replicate, rather than generate new, cultural memes and practices. The capacity of the adaptive processes, in this context, then, is minimal, which can lead to atrophy. An example would be reasoned argument developed within a set of beliefs and practices and ritualised over time (replicating system) without ever challenging the original premise and purpose out of which such beliefs and practices arose (generative system). As structures and processes relate to fundamental human needs, such as belonging, safety and identity (Maslow, 2014), there is fear of the unknown and of potential loss of identity, meaning, cohesion and certainty if the premise itself is challenged.

Although cultural ecologies are adaptive to external and internal influences to survive, this adaptive process can vary in terms of degree of adaptability. On the whole, 'agents of change' are usually those who wish to enhance their culture's adaptive processing systems to make them adapt appropriately to stimuli without losing entirely the culture's function and identity. This is not the same as setting out on a mission to 'change the culture'. In higher education, the facilitator (in this case, the supervisor) of this 'enhancement of adaptive processing' that is going to take place within a cultural ecology, through the agent (in this case, the 'researcher'), is part of any potential adaptive process and, indeed, its success or failure. Awareness of this is a responsibility that the supervisor needs to recognise and to bring this into the awareness of the researcher. Such awareness motivates the development of anticipatory skills through a more sophisticated conceptualisation of the researcher's context and more rigorous attention to the appropriateness of methods and the implications of impact. As Joseph Campbell (1990) pointed out in his analysis of myths, the one who seeks to make changes and goes on a transformational journey to find what is needed by their society often returns to that society with the 'treasure', not as the hero but a danger to the culture that must be expunged. Is it not then our role as facilitators of research in higher education, which is intended to bring

about 'change' in cultural ecologies outside higher education, to take this responsibility seriously and to critique our own professional practice and the expectations we have of ourselves and which others have of us?

I suggest that the first step in this TD as an anthropological approach to global learning is a conceptualisation of professional practice within any cultural ecology, including the professional practice of research facilitators and teachers within higher education, which can both recognise and work with the capacity of adaptive processing systems. TD is a conceptualisation that can map out the complexities, foreground the communication pathways, reveal the areas requiring attention, identify where communication and exchange have become bottlenecked, and more accurately anticipate the implications of change. Critical reflection is one of the crafts that can both map-make and map-read professional practice. For those undertaking or about to undertake research in a work environment outside of but through higher education, it can influence the choice of research methodology and define more clearly the purpose, the feasibility and the appropriate knowledge fields to explore. Successful change and innovation fundamentally require collaboration, and that can only take place if the exchange channels are fluid and flexible. TD has highlighted in its discourses facititating factors to fluid exchange that fill out the conceptual map, including: trust (Harris & Lyon, 2013; Lyon & Mollerling, 2012); coherence, not unity (Ramadier, 2004); negotiation, not 'research'; relationship with temporality, not linear time (Maguire, 2015a) and place and space no longer embedded in dwellings (Augé, 2009).

An anthropology of learning is a learning about what matters (Hasse, 2015) and in roles as facilitators of research we need to find what matters out there to the people who live and work in fast-moving environments in layered contexts, from NGOs to global corporations, that includes mattering as a human being, not only as an instrument. Engaging with the anthropological perspective is valuable as we strive for more synergy between ways of knowing, because anthropology is not, in the traditional sense, a discipline. It is a seeker and observer of human activities, clustered together in groups, on islands, in factories, in relationships and manifested and sustained in rituals that seem to hold the group together in common identity, and often prevents others from entering unless for the purpose of alliances.

Our curiosity as researchers, supervisors of research and teachers is about what facilitates the relationships between cultural islands and how epistemes are transferred. This brings to mind the role of merchants – the seafarers who communicated between islands, regularly pollinating epistemes and contributing in no small part to the networks that link us together, increasing the layers of knowing in which we exist and can thrive. Therefore, the anthropology of learning is how to navigate difference in order to negotiate the harnessing of knowledge and the generation of new knowledge for the things that matter.

In my conceptualisation fantasy, TD, in this anthropology of learning, seeks out the smaller narratives to enlighten and challenge even the grand narratives that have marginalised as much as included, and have been examples of disabling as well as enabling. McDermott and Varenne (1995:325), in their concept of culture as

disabling, challenge the notion that culture is a container of coherence, postulating that the container leaks as

> 'the coherence of a culture is crafted from the partial and mutually dependent knowledge of each person caught in the process and depends in the long run, on the work they do together...Culture is not so much a product of sharing as a product of hammering each other into shape with the well structured tools already available.'

TD offers the possibility of a coherence that does not leak, because it is not a cultural container and has no need of hammering. It offers the possibility of emancipation from well-worn rituals, the purposes of which have been forgotten. It does not destroy disciplines, but seeks to release them from too rigid containment.

Hasse (2015) sees the researcher in some form as ethnographer. Resonating with Joseph's Campbell's work, the researcher is 'the *radical other* in the empirical field' (2015: 199). The ethnographer participates in the very life of the culture, but *with a different motive* from the culture's members who are embedded in what have become *self-evident connections*, and whose identity and survival is entangled with that of the culture. The anthropologist makes possible an analysis of the culture in order to understand its capacity to enlighten the constructs of human behaviour and thus manipulate or appeal to them for a range of purposes. These include decreasing the power gap between populations caused through monopoly of world resources, to solving complex global problems that threaten the future of the planet, to ensuring that public health policies are inclusive.

12.5 Transdisciplinarity and Translator

No anthropologist would be worth their salt if they did not speak about the importance of language, but I am not speaking here of linguistics, rather cultural narratives of rituals and practices, and the art of translation. If the anthropologist contributes to understanding through research, how then is that research used for what matters? The enlightened researcher or ethnographer accepts that the selection of what matters is never value free; the researcher/ethnographer is part of the phenomenon being studied and is already influencing the adaptive processes of herself and the members of the culture being entered. Hasse, drawing on Ingold and Barad (2015: 15), lays out the task to be carried out: 'the expert ethnographer must, as learner, strive to become a culturally informed apparatus that learns what matters in other people's practiced places'. Ingold (2011: 239) rightly points out that anthropologists have rarely 'sought to spell out exactly what craftmanship entails' (Hasse, 2015: 2). But there are clear indications of anthropologists' insights and understanding of craftsmanship, including their own, through their observations, participations and analyses embodied in the vast amount of materials that they continue to produce of these encounters with peoples in situ over time. These include film, texts and objects of significant scholarship, ranging from witchcraft to kinship, from child rearing to social and economic transactions. Margaret Mead was not alone in

analysing her observations in terms of craftsmanship and how people learn through symbolic and utility relationships to objects influencing, in her case, the thinking of several eminent psychologists of the twentieth century (Gerhardt, 1995; Maguire, 2015a).

In my proposal of transdisciplinarity as an anthropological approach to global learning, I see the prefix as key to the role of the disseminator, whether teacher, researcher or analyst. In my conceptualisation, the disseminator is not the replicator of cultural epistemes, but a translator across different cultures of beliefs and practices whose key purpose is the cross-pollination of different knowledges to arrive at knowing as a way of being in the world by addressing ignorance. The translator achieves this through an array of Hermesian tricks: metaphor, imagery, recontextualisation, narratives, myths and archetypes. Having an expert translator is one of the conditions needed for understanding to take place (Gadamer, 2013). Translators recognise that their role and location is, as Duarte, Rosa, and Seruya (2006) describe, not

> one that would take us into the terrain of epistemology, the ground where knowledges are produced and transmitted and hence into the heart of 'ghostly' disciplinarity. We propose therefore that we call – to stick to terminological coherence – knowledgescape the migration of ideas, concepts and methods across disciplinary bounds that increasingly characterise the field where research in the humanities is staked out today. (2006: 4)

Therefore, I see the key figure in TD as the hermeneut (Maguire, 2015b), the skilled conduit bridging different realms of experience with a range of attributes, including those proposed by Hasse required for the expert anthropologist/ethnographer. Returning to Goethe's words on language at the beginning of this chapter and recontextualising them for a contemporary world, a foreign language can be seen as Bakhtin's notion of heteroglossia, described here by Greenall (2006: 70):

> Heteroglossia or multivoicedness, is a concept which links up with the… idea of social meaning-creating activity as a negotiative activity; whenever we negotiate and hence (re-) create meaning, we always leave a trace of our influence, a trace of our voice… this means that texts and discourses become choirs of voices we leave behind: they become heteroglossic.

The hermeneut/translator requires the capacity to accumulate and hold multiple voices and traces, a foreign language not only in terms of texts but of the varieties of artistic expression, which are as much a defining feature of human expression as text. For the anthropologist, 'the art of cultural translation consists in oscillating between distance and nearness, between one's own concepts and the native ones, or – to put it differently – making the exotic familiar and the familiar exotic' (Eriksen, 2009: 34), thus avoiding the straightjacket of reality bounded by 'home-blindness' (ibid.).

Returning to Einstein's 'Make everything as simple as possible. But not simpler', I like to think it refers to the beauty of distillation – another skill of the gifted translator. Einstein, a master translator himself, offered us perhaps the greatest distillation of knowledge that, as well as being an equation of the highly complex theory of relativity, has become a metaphor for the extraordinary capacity of the human being to evolve and adapt if we embrace the complexity of the universe rather than attempt

to control our fear of it. The facilitator of research needs to distil a range of knowledges and to communicate them in a way that is simpler, yet not simple. Metaphor, image and mapping are distillation tools. Skilled distillation provides the key to doors that we would not normally open, because our rituals and beliefs are embedded in our historical particularities. Einstein's equation made possible our relationship with that which exists outside of our own planet for everyone, not just for scientists. It was an opening up to the interconnectedness of things.

12.6 The Value of Ignorance

The anthropologist has an enlightened view of ignorance, appropriate to the contemporary world, and that is a positioning of ignorance as the tool of awareness. Ignorance has come to be a pejorative term in English. Returning to its Latin root of 'not knowing', as not in awareness (gnarus: aware), it can be seen not only as a motivation to know but a position to take in order to become aware, which requires challenging one's own homeblindness (not in awareness) in order to understand the other.

The anthropologist as researcher starts from a position of positive ignorance, 'a basic condition for an ethnographer… and a professional value' (Hasse, 2015: 269, 270). This is ignorance that is open to learning *of or about* the thing, as much as possible without prejudice. The anthropologist as a facilitator of awareness between difference, the hermeneut, uses their skills to increase awareness 'between' things through accumulated knowledge of what arises from multiple exchanges across differences. One could postulate that, just as the success of an algorithm is dependent on the constant updating of the quality of human data and skill that is fed into it, so then is the 'success' of research, as suggested above, dependent on the quality and experience of input from the research facilitator as hermeneut 'between' and the researcher as ethnographer and hermeneut 'within'. For the research facilitator within higher education today, this requires a constantly deepening awareness of the purpose and methods of our own professional practice and how it might challenge the cultural ecology, in which we function, to undergo its own adaptive processes to meet the imperatives of the wider and more powerful systems in which it operates. This adaptation needs to be beyond compliance, which can replicate increasingly redundant approaches to the generation of new thinking that does not totally destabilise the ecology but makes it more resilient and creative. An anthropological approach cannot force systems to use awareness well; it can only offer rich data that can make it confident in its stability in a less-confining way. This tension between compliance and creativity has provoked responses by some educators to use the term 'epistemologies of ignorance' to describe the dominant knowledge paradigms that continue to replicate rituals of thinking to guard the stability of the cultural ecology. Malewski and Jaramillo (2011: 2), for example, call for 'emerging scholars in education to question ignorance, as the active production of 'unknowing' in order to keep in motion "the way things are" instead of thinking about "the ways things could be"'.

12.7 Learning Purpose

Our relationship with objects and materials, including theoretical objects and materials such as concepts and paradigms, constitutes practice. Human interaction with the constituents of environments is the seedbed of human learning. Is this the learning that we need for the future? Can we create and use the connectivity of globalisation more creatively through challenging existing formulations? Morton (2013) has posed a reconceptualisation and recontextualisation of the objects with which TD also concerns itself: high-impact problems such as global warming, exclusive ideologies and social injustice. This interests us as facilitators of learning through research. Morton challenges not only our definitions of objects but our relationships to them, and thereby our learning from those interactions. He redefines the objects that matter to the survival of the planet and its inhabitants as hyperobjects. His position resonates with attempts by transdisciplinarity and anthropology to have more meaningful dialogues with complexity; dialogues that cannot be supported by the ritualistic thinking to which philosophy is also prone. He grasps the notion that there exist objects in our world that impact our lives, our very existence, but are 'massively distributed in time and space relative to humans' (Morton, 2013: 1). Examples might be a biosphere, such as the rainforest, or nuclear materials, eternal plastic forms or ideologies:

> Hyperobjects have numerous properties in common. They are viscous, which means they 'stick' to beings that are involved in them. They are nonlocal; in other words, any 'local manifestation' of a hyperobject is not directly a hyperobject… they involve profoundly different temporalities than the human scale ones we are used to… hyperobjects occupy a high-dimensional phase space that results in their being invisible to humans for stretches of time… The hyperobject is not a function of our knowledge… They have exposed the weakness between the phenomenon and the thing which the hyperobject makes disturbingly visible. (ibid.: 1, 2)

This is an example of how language itself is a ritual that can inhibit how we perceive and conceptualise 'things' and our relationship to them, and can also be the device by which a new ritual of thinking can emerge and dominate. It requires of the translator a willingness to conceptualise boldly, which for Morton is in a non-anthropocentric way, and to be open to evolving 'tricks' to enhance understanding with and between objects, from humans to the solar system. For him, intersubjectivity can only be understood if it does not exclude the media that organise and transmit human information, 'such as classrooms and cell phones and markets. 'Intersubjectivity is a particular instance of interobjectivity' (ibid.: 81, 82). He uses 'mesh' to describe what an anthropologist or proponent of TD may call layered contexts, complexity, metissage and networks to explain the nuances of our relationships to objects and to offer conceptual frameworks for extracting and organising learning from the interplay between the constituents of our environments, including materials, objects, peoples, phenomena, paradigms, events, beliefs and histories. That interplay is our practice, and practices are the cohesive threads of

identity and belonging. At times, the purpose of learning, like an unwatched quantum object, can be fuzzy until close observation brings it into reality.

What, then, is this purpose of learning and, indeed, of global learning that we need to observe closely if we are in roles that intend to facilitate its extraction through engagement with research in and across the world's cultural ecologies? The world is the object and our learning arises from our relationship to it. This hyperobject contains many smaller objects, constituted as cultural ecologies that have become increasingly interlinked. TD as a global anthropology of learning has something to say about the intention of learning and the knowledge that it produces to resolve local, regional and global problems. It does this through a focus on understanding the understanding of each partner in the interdependency, circumventing any single dominant paradigm by inclusion of many voices to arrive at benefits for a range of stakeholders that does not marginalise the traditionally less-affluent, less-voiced members of society in favour of the political and financial coloniser. In terms of higher education and research in cultural ecologies outside of the cultural ecology of the university, it offers first, a conceptualisation of the context of the location and the embedded practices that take place there to inform a set of research strategies, including how and with whom, for the most relevant outcome and impact that will not destabilise the whole ecology. Second, such an approach through a TD conceptualisation enhances the chances of the research being an agent of capacity building in adaptive processing in interconnected ecologies or what, in academic circles, is amorphously referred to as 'contributions to professional knowledge'. This requires of those tasked with facilitating such research to undertake that which is also expected of their developing researchers – an increased awareness of what informs their own practice and of what is required to practise with an attitude of responsibility and multivoicedness.

Institutes of higher education can offer fertile acreage for learning about embedded rituals, silos, resistance to change, reactive vision and out-of-awareness strategies that can alienate their own members. There is no finality of learning and understanding, yet. The variables in the human condition are multiple, and learning can be harnessed for different motivations and intentions. If higher education, as embodied in universities, is to have an influential position in the interconnectedness of things, a situation that is both increasing and reducing cultural ecologies' adaptive processing abilities, it needs to open up to the possibilities of other ways of thinking and doing.

TD as a global anthropology of learning is only one of the emergent responses to the complexity of knowledge growth and its purpose. TD is, for the moment, a conceptualisation of how to influence complex adaptive practices to increase the potential for a more stable and inclusive connectivity that is the neural pathway of global learning.

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Chapter 13
ArtScience and the Metaphors of Embodied Realism

Brett Wilson

13.1 Introduction

Over the last decade, the academic world has moved much closer to recognising that a narrow disciplinary approach to knowledge and understanding is, at best, a convenient organisational fiction and, at worst, a conceptual bottleneck, limiting how we deploy our imagination, both as individuals and societies (Nowotny, 2012; Ox, 2014; Root-Bernstein, Siler, Brown, & Snelson, 2011). Such voices are not entirely new, of course, but it is only in the last 20 years or so that the growing chorus has started to receive wider attention. A transdisciplinary approach to how we problematise our world, in general, and a deeper awareness of the wider theatre of enacted solutions are now gaining serious traction across divergent communities of practice. For example, we see a broader Science/Engineering/Art/Design (SEAD) higher education curriculum gaining currency in the US (Malina, Strohecker, LaFayette, & Ione, 2013); organ-transplant recipients are playing out their fears through theatre and immersive-installations (Pynor, 2014); and non-governmental organisations (NGOs) are exploring peace-building through performative strategies in conflict zones (Stephenson & Zanotti, 2012).

A transdisciplinary approach to knowledge and understanding has a number of advantages for the way we view our world and partition information and experiences. This chapter focuses primarily on two intertwined strands of this perspective, in particular: the problem of constructing a workable aesthetic framework for the emerging joint practice of art and science, now that the previously rigid boundaries between the sensibilities of the arts and sciences are becoming much more permeable, and how a transdisciplinary approach would influence our understanding of the scientific imagination.

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Lakoff and Johnson's recent work (1999) on embodied realism offers a very promising standpoint from which to re-imagine the interaction between art and science and provides analytical leverage for creating an aesthetic framework for the emergent ArtScience movement, applicable to both its artistic and scientific practitioners. In addition, the growth of areas such as practice-based arts research has forced us to look afresh at what constitutes research in principle and whether the 'scientific method', as practised across the laboratories of the world, is actually as unique as previously claimed, or whether it is simply a particular stylisation of a broader approach to puzzle solving. Both of these developments have implications for our understanding of how scientific theories are formulated. In particular, while the philosophy and socio-epistemology of scientific theory formation have been studied for some time, much less attention has been paid to the processes and tools by which our scientific imagination creates such wonderful – and at times quite bizarre-sounding – theories in the first place. The whole matter of the scientific imagination has received relatively little direct attention by scientists in the past, but with continued developments in second-generation cognitive science and imaging technologies, we are beginning to realise that the cognitive mechanisms implicit to our scientific interactions with the physical and world depend crucially on non-literal conceptual factors that have traditionally been more usually associated with the arts and humanities (Kemp, 2006; Wilson & Sim, 2015).

On the broader societal front, a transdisciplinary approach to knowledge and understanding also means that we are able much more to confidently frame and investigate questions that only a generation ago would probably not have merited serious contemplation, either because they straddled too many traditional academic fault lines or were thought to be too ideologically motivated. We have come to appreciate that many of the important problems that face the world in the twenty-first century cannot be tackled by narrowly focused disciplinary solutions alone, especially if they simply take the form of short-term technological fixes.[1] Indeed, many argue that problems such as climate change have been exacerbated by uncritical deployment of technology in the first place, often in pursuit of quick and easy profit at the expense of a more sustainable long-term attitude to management of our local and planetary environment. Food and water security, protection against climatic extremes, political enfranchisement, economic stability and ethical trade, affordable housing and education, effective healthcare and medical provision, social mobility, freedom of expression to both practice and criticise beliefs, and rule of law

[1] Social trust in current formulations of technoscience appears to have become undermined for two main reasons (Saltelli, Ravetz, & Funtowicz, 2016). First, because science has failed to position itself wisely with respect to the public – who ultimately, of course, fund it. Scientists, technologists and their associated professional bodies too rarely engage in meaningful discussions with potential stakeholders, generally preferring not to have their authority challenged by lay people or bodies, even when the very same people may be directly and intimately affected – as patients, say (Platten & Biggs, 2014). Second, 'evidence-based policy' can too easily become transformed into 'policy-based evidence' (Saltelli & Giampietro, 2016) under the prevailing orthodoxies of professional bodies, the narrow financial focus of corporate boardrooms and the ideological imperatives of government.

with an independent judiciary are not just the preoccupation of liberal Western societies, but the foundation stones of everyday civic life that societies strive towards, once the immediate and pressing threats of day-to-day physical survival are overcome.

However, these are very complex problems that go right to the heart of how we see ourselves: as individuals, as social actors, as cultural vectors and even as a species on the '3rd rock from the sun' living among countless other species with an equally valid evolutionary claim to existence (Guattari, 2008). How we even start to frame these vital questions requires a 360 degree view of life that immediately takes us beyond the rigid confines of traditional disciplinary categories to find workable and enduring solutions. How we classify, partition and process information against the backdrop of prevailing cultural and intellectual orthodoxy profoundly influences the range of potential worlds that we can imagine, or indeed that are deemed either recognisable or acceptable – either to ourselves, other individuals or society at large. There are promising indications that we are at last starting to do this, but these tentative steps need consolidating in the face of other, sometimes more immediate, concerns created by a resurgence of fundamentalism (both religious and economic) in its various guises around the world.

13.2 Science and Art

One of the most evident and significant disciplinary divisions over the past century has been between science and art. Under modernism, science has been portrayed as cold, detached, objective and ruthlessly logical in its pursuit of functional utility, whereas art in contrast is popularly seen as decorative, subjective, emotional and the highest expression of an individual's unconscious creativity. In their traditional forms, they often appear to the general public – and many academics and practitioners – to be distinctly different, incompatible and based on immiscible modes of enquiry operating with divergent underlying rules and attitudes to our world. Fortunately, such extreme polarised views have gradually been dissolving as scientists and artists have started to work together more frequently and come to realise that they share many common underlying practices relating to imagination and visualisation (Wilson, Hawkins, & Sim, 2014). As physicist Brian Cox (Royal Society Professor for Public Engagement in Science) stressed when presenting the Royal Society's 2016 science book prize for Andrea Wulf's biography of Alexander von Humboldt (*The Invention of Nature*), 'Moreover, he [Humboldt] was a polymath who was curious about everything and was a superb communicator. *His interdisciplinary approach puts paid to the ridiculous notion that science and the arts are separate entities*.' (Cox, 2016, emphasis added.) A growing number of practitioners are realising that art and science are indeed both intimately concerned with how we conceive of the world and share a common embodied imagination, cognitive creativity and independent spirit of enquiry at their heart, and both are capable of summoning up the visionary power of revolution for our senses. The growth of

practice-led arts research has also helped to establish a stronger academic basis from which a productive dialogue with scientists has emerged, gradually bringing scientists to the realisation that different 'ways of seeing' are at the heart of each new paradigm, and that non-literal forms of conceptualisation also play a huge role in how they strive (and indeed, are forced) to continually re-imagine the world in the light of new discoveries (Kemp, 2006). The professional world of scientists, just as much as artists, depends crucially on learning how to perceive, look and conceptualise. In effect, both groups are searching for credible explanations for what they have discovered, constructed or experienced. Scientific 'looking' also has a history that can be studied; a history that encompasses far more than just the notion of objectivity that many scientists and the general public still assume to be the defining characteristic of modern science (Galison, 1998). Regrettably, few science students are ever taught that the visualisation of concepts essential to their subjects is so strongly rooted in contemporary conventions (Campbell, 2004).

13.3 What Is Research?

Even with the recent growth in transdisciplinary projects encompassing art and science, the majority of university practitioners across the sciences, arts and humanities rarely have occasion to spend research time together with others from different disciplines. Within our present micro-managed goal-oriented and over-administered environment, academics seem to have far fewer opportunities to talk to one another over lunch or coffee about the broader aspects of academic life in general than previously has been the case, even in institutions where common rooms still exist. Lunch at the keyboard is becoming the depressing norm for a new generation of academics. This is extremely unfortunate, since listening to, assimilating and responding to arguments, criticisms and conceptual models from colleagues in other disciplines and appreciating how they go about their 'ways of knowing' helps to bring into much sharper focus the knowledge values and boundaries associated with our own respective research communities (Wilson et al., 2014). Discovering how the often-camouflaged foundational assumptions and ideological baggage of one's own field of research are seen through the eyes of practitioners from other disciplines helps to reveal underlying commonalities in research processes and broadens our perception of the relationship between the arts, sciences and humanities. As many have already discovered, talking to others outside your central area of expertise has the potential to make you a better researcher within your own field by opening up fresh perspectives on old questions.

The recent growth of arts-based practice-led doctoral research is an interesting case in point. Such practice-led arts-based research programmes almost always encompass a mix of constructed and expressive artefacts. These may be passive, physical and enduring, but on the other hand they may equally well be performative, experiential and transient. The very nature of such works creates new and potentially difficult questions about the relationship between the locus of the research and

any accompanying textual description and analysis that constitutes the traditional thesis expected by the academy. As a consequence, arts-based practice-led doctoral research has served to raise a number of pressing questions within the academy about what actually constitutes research and how it should be presented and evidenced (Kälvemark, 2011).

So what does constitute research? Asking this question of a diverse range of practitioners almost always elicits replies that reflect the scope, purpose and language closely linked to the disciplinary background of those responding. In contrast, trying to formulate a working definition of what constitutes research that is equally useful across the arts, sciences and humanities requires terms that are simultaneously pertinent, accurate and recognisable, yet apply across diverse academic fields. Having moved from the lab bench across into an arts faculty as a 'scientist in residence', the author has had the opportunity to explore such questions within a much wider academic context than is usual. Growing out of these interactions, the broadest workable definition of what constitutes research in general that has satisfied colleagues from across different communities of practice is that: all research resides in questioning and challenging fundamental conceptual structures, models and metaphors in one way or another, or proposing a conceptual model where none has previously been acknowledged in any given field (Wilson et al., 2014). If your work is challenging, bringing into question or testing an established conceptual model to its limits, then you are doing research, irrespective of your particular field or job title. Similarly, if you are proposing a conceptual model in an emerging field, then you are also engaged in research. Research proceeds in general by asking explicit or implicit questions, and it is the nature and quality of these questions that determines the usefulness of the outcome. To get good answers, first you have to learn to ask good questions – and, to discover powerful paradigm-shifting answers, you need to devise extremely insightful questions**.**

Keeping in mind this broad view of what constitutes research, it follows that presenting visual, aural or performance-based material as an integral element alongside a text-based thesis to form part of an arts research programme for evaluation is, in principle, essentially no different to a traditional scientific PhD, when viewed through Anderson's wider-angle analytical auto-ethnographic lens (Anderson, 2006). In both cases, it needs to be demonstrated how investigative laboratory experiments or innovative studio works constitute creative artefacts that act as respective sites of discourse, embodying and exercising the central research questions under study using language specific and appropriate to the enquiry. Both represent the public face of private imagination acted out through cultural processes, and the critical closed-loop path that is considered such a distinctive feature of scientific enquiry is also clearly evident in the debate, review and critique adopted by contemporary arts-based practice-led reflexive practitioners.

Once you adopt a broader descriptive language of what constitutes research, numerous tempting parallels spring to mind regarding the 'culture of experiment' in art and science. Studios and laboratories can both be described as places of discovery and curiosity, where new conceptual structures and investigative methods are explored, where mastery of craft and expert judgement play important roles, where

new metaphors can illuminate unexpected directions and consequences, where teasing obliquely glimpsed possibilities into working artefacts is often decisive, and where crafting work in progress towards a state of exhibition, inspection and judgement by fellow professionals, sponsors and the wider public is a strong driving force for both scientists and artists alike. Labs and studios are also important venues for learning the *craft* of being a researcher, and of learning to play your role within your respective research *community* – territory important to understand regardless of your particular disciplinary field (Wilson, Hawkins, & Sim, 2015).

13.4 Science vs Art?

Accounts from earlier Sci-Art projects in the UK show that collaborating scientists and artists saw the role of scientists in general as being to uncover previously existing objective evidence in a physical world, and both parties agreed that the artists, through their labour and original creativity, were producing artefacts that embodied some form of inter-subjective cultural expression (Glinkowski & Bamford, 2009). This distinction between scientists discovering pre-existing knowledge-objects temptingly embedded in some form of theory-neutral external reality ripe for the picking, contrasting with artists who labour to conjure up subjective works from within their own minds dates back to the Enlightenment's separation of artistic and scientific sensibilities and still occurs widely in popular discussions concerning art and science. This view has a long history, as may be seen in the legal protection of scientists' and artists' intellectual property rights, which long ago developed according to two entirely separate sets of legislative assumptions (Leach, 2011: 145): patents (discovered) and copyright (created). Fortunately, these easy distinctions are being increasingly challenged in postmodernity as we seek a deeper understanding of how we, as humans, perceive and interact with the world and each other.

However, much of what constitutes the background philosophical framework of many contemporary scientists and artists is underpinned by what now appear to be archaic assumptions. The intellectual, industrial and economic expansion in the West that characterised the eighteenth-century European Enlightenment programme was crucially dependent on the disenchantment of science – in which matter effectively became 'de-animated' – but it did not depend on the idea of objectivity (Ravetz, 1990: 105). The notions of mechanical and structural objectivity were only adopted in scientific enquiry around 1830, following the previous 'truth to nature' standpoint of the Romantic era, and only lasted for just over a century before evolving into the current ideas of 'expert judgement' (Galison, 1998). Yet the notion of objectivity still imparts a powerful influence on what contemporary scientists, artists and the general public take to be 'modernity', where utility is expected of science through technology to fuel never-ending consumer growth, and art is seen as an aesthetic expression of inter-subjective knowledge personally created by the artist, yet in relation to wider cultural norms. Fortunately, there are now intriguing pointers emerging from second-generation cognitive science offering a promising

route to a deeper understanding of both the conceptual and perceptual mechanisms by which artists and scientists see their respective worlds, and which show that they are probably not so different after all (Carrier, 2011).

13.5 An Embodied Aesthetics of ArtScience?

A number of recent editorials in the American journal *Leonardo* (established in 1968 by the International Society for the Arts, Sciences and Technology) have highlighted key ideas and attitudes of the new generation of emerging ArtScience practitioners (Ox, 2014; Root-Bernstein et al., 2011). Compared to the earlier Sci-Art movement in the UK, one of the points of departure for ArtScience is that artists are now actively seeking to create research partnerships with the various scientific communities, rather than simply passively reflecting science-inspired motifs or concepts in their work (Hawkins, 2014). Similarly, scientists are also beginning to appreciate more clearly the value of building working relationships with artists in roles and projects beyond those of routine scientific illustrators (Ox & Lowenberg, 2013).

An important feature of ArtScience's manifesto is that it aims for a broader and more integrated engagement across a wide range of societal and global problems, as noted in the introduction. However, despite ArtScience's early signs of promise, for it to gain real traction as an enduring cultural and educational phenomenon, it still needs to develop a stronger theoretical underpinning to deal with questions and misconceptions that will inevitably arise when creating a workable partnership between the sensibilities of the arts and sciences. Even though many practising artists and scientists are now happy to work together on mutually inspired projects, there can still be a strong divergence in their underlying ontological and epistemological frameworks. Consequently, there is a pressing need to re-examine the deliberate separation of art and science that has been such a defining feature since their Enlightenment reformulation. In order to see more clearly how ArtScience could acquire its own embodied aesthetic, it is helpful to reflect on the historical and philosophical origins of our contemporary attitudes to art and science and the limitations imposed by the Cartesian subject-object dichotomy on which so much thinking is still predicated. We are then able to draw on recent developments in philosophy around the notions of conceptual metaphors and embodied realism to offer a richer landscape in which to situate a 'philosophy of the flesh' that avoids the pitfalls of Cartesian mind-body dualism and open up a credible route to an enduring form of ArtScience.

13.6 Cartesian Duality and Disembodied Realism

It is instructive to ask how we have arrived at our presently accepted ideas regarding how we as individuals can know and experience a world external to ourselves.[2] Integral to this question is whether we consider our mind and its conceptual processes to be somehow different and separate from our physical brain, body and the outside world (i.e. disembodied), or whether we consider the processes of thinking, reasoning and experiencing to be intimately connected to our physical brain and body situated in a network of other broadly similar organisms (i.e. not just embodied in an individual sense, but ultimately socially and culturally embodied as well). Descartes drove a firm wedge between the mental faculties of a reasoning mind and the experiences available via a physical body and the world in which it is situated (Cottingham, Stoothoff, Murdoch, & Kenny, 1988) – a gap that earlier classical Greek philosophy did not recognise as valid. His notion of mind-body dualism and the consequential subject/object dichotomy critically influenced the development of Enlightenment thinking and has become central to the school of Western analytic philosophy developed by Frege, Russell and the early Wittgenstein, among others (Glock, 2008).

This 'disembodied' approach to what there is (ontology) and what we can know (epistemology) meant that object and subject became foundational categories of modern analytic philosophy, seeming to legitimise in retrospect our polarised approach to art and science via the European Enlightenment project. As a consequence, in modernity under Western analytic philosophy it has been virtually impossible to discuss any underlying qualities or values that might be shared by art and science, since they were framed as orthogonal domains: the one never able to throw illumination on the other. Even under the more challenging and sceptical attitude of postmodernity, we still struggle to discuss any potential aesthetic of science, preferring to attack it primarily for its presumed 'privileged narrative', rather than seeking to question and reformulate its disembodied tradition (Sim, 2011).

What shape should an embodied aesthetic for ArtScience take if it is to embrace ethics and morality, as its supporters proclaim? Western aesthetic practices have broadened in form and focus over the last generation to extend far beyond the narrow eighteenth-century contemplation of beauty in art and nature; first to include diverse categories such as the natural environment, the built environment (architecture) and popular art, and now almost any design activity that affects people's lives

[2] Although this question is usually posed in the singular, the primacy of 'self-knowledge' over 'social-knowledge' cannot simply be assumed without the unwitting danger of seeming to perpetuate 'the socio-cultural myth of individualism' (Cubitt, 1998: 142). The nature of 'self' and the insights that we can gain will always be problematic when constrained by strong disciplinary boundaries. For example, is it more useful to approach the nature of an isolated 'self' as being contained within the limits of our physical boundaries, or do we gain deeper understanding by looking at how it extends, in the manner of a distributed probability function, out into our family, friends and society at large? Ramachandran's 'mirror neurons' (2012) suggest that even at the fundamental neuronal level we are organised to respond intimately to the presence and behaviour of others.

through sensuous qualities such as size, shape, colour, smell, texture and so on. In its broadest sense, aesthetics is now taken to include interaction with, rather than simply contemplation of, everyday artefacts and environments, whether natural or human-designed, that engages our senses on either a consciously-noticed or unconscious level (Kwastek, 2013). By progressing to a more performative notion of aesthetics that embraces our individual and social behaviour and attitudes towards others (both human and non-human), the West is eventually catching up with societies in other parts of the supposedly 'under-developed' world (Leach, 2011: 146).

However, we also need to be cautious. Broadening our aesthetic gaze to bring within its remit everyday acts of the mundane while helping to diminish the anti-democratic hold of a 'culture of exclusion' (Saito, 2007) raises the potential danger of 'legitimation of the useless commodity', as Cubitt (1998: 141) warns us. Corporate exploitation of possessive individualism (MacPherson, 1962) creates traps for those trying to comprehend the emerging 'digital' conceptual economy and any aesthetic shift associated with it. Hopefully, through an embodied aesthetic, ArtScience will be able to deploy its moral and ethical dimensions to challenge the often brutal acts of economic colonialism enforced in the name of technoscience by both multinational corporations and sovereign entities. Digital technologies undoubtedly offer huge new creative opportunities across the arts, but we must remember that entropy demands that a price be extracted for the infinite reproducibility of digital imagery in all its forms, and the currency will be in cultural and intellectual watchfulness. One of the unique – but also potentially dangerous – aspects of digital technologies is that they are able to free large multinational entertainment corporations from directly merchandising physical media, allowing them instead to exploit the far more lucrative and attractive (to them) subscription retail model that binds customers contractually over time, as with Netflix and the rise of virtual box sets.[3]

Once we appreciate how an embodied aesthetic could be conceptualised for ArtScience, it is evident how a more inclusive notion of moral and ethical considerations would replace the analytic 'rational-actor' model based purely on self-interest that is current within neoliberal economies in the West as the basis for decision making, from individual behaviour through to corporate and sovereign policy. Being able to ask 'is this policy in the long-term interests of the planet and its inhabitants?' is a far more powerful and democratic form of decision making than simply having to accept technological developments, whether digital or otherwise, simply because they are imposed via largely unquestioned economic norms backed up by an anachronistic and disembodied form of aesthetics developed several centuries ago in a very different intellectual age.

[3]This has become especially noticeable in advanced industrialised societies within which consumer-driven markets are increasingly created, serviced and manipulated by a relatively small number of transnational (global) companies such as Google, Microsoft, Amazon, Apple and Sony for example, most of whom have effectively moved beyond the effective reach of national legislation into the far more tax-efficient territory of cyberspace.

13.7 The Science of Enlightenment

In their broadest manifestation, scientific theories offer individuals and societies credible explanations of their external (and internal) worlds; a function that they still share with religion in general. However, only science offers predictions that are uniquely testable in this world, rather than the next.

As Jim Baggot notes in his recent account of scientific theorising (2013):

> Although physical theories are constructed to describe empirical facts about reality, they are nevertheless founded on abstract mathematical, almost metaphysical, concepts. The process of abstraction from facts to theories is highly complex, intuitive and not subject to simple universal rules applicable to all science for all time. In the act of scientific creation, any approach is in principle valid provided it yields a theory that works. (Baggot, 2013: 17)

It has been taken as axiomatic since the emergent classical period of science around the middle of the nineteenth century that, for a theory to be considered scientific, it should be testable in some way by comparing its predictions to existing or new information. A cornerstone of scientific modernity is that every new theory should offer a coherent account of results already obtained within its scope as well as successfully predicting the outcomes of as yet un-performed experiments that would not have been conceivable under the old theory. A conceptual model and its associated mathematical formulations that tally with existing results and which offers falsifiable new predictions that turn out to be accurate stands every chance of quickly becoming accepted into the 'authorised version' of science acknowledged across the scientific community.

Significant refinements to our understanding of how scientific theories function appeared during the twentieth century from Karl Popper (1959) and Thomas Kuhn (1962), the former a proponent of falsifiability in the form of testable predictions as the major criterion of a good theory, while the latter gave us terms such as 'paradigm', 'normal science' and 'scientific revolution' to enquire more closely into how scientific understanding and theorising take place. Popper's falsifiability criterion is still generally employed today as our best approach to evaluating scientific theories, but with the caveat that if a single test shows that a theory's predictions are false under certain specific conditions, it is not necessarily abandoned immediately, as one or more of the auxiliary assumptions may be wrong and the theory can be saved through reformulation (Harding, 1976; Lakatos, 1978).

Popper is often regarded as being among the last of the modernists, with Kuhn as a herald of emerging postmodernity, but such a reading ignores many of the subtle connections to be found within their work and that they were largely describing opposite sides of the same coin: Popper the structure of theory and Kuhn the socio-epistemology of theory acceptance. As Steve Fuller notes (2006: 25), Popper's tool of falsifiability was intended for mounting continual challenges to the scientific status quo, rather than a technique to be used in support of it. In this respect, his sceptical stance is much more in tune with postmodernity then he is usually given credit for.

Structural objectivity still imparts a powerful influence on what contemporary scientists and the general public take to be a central pillar of scientific theorising. The frequently repeated sentiments of scientists that their theories and experimental work are based on some form of 'objective reality' that can be independently accessed by carefully-structured experiments and scrupulous removal of personal bias is a position that effectively conflates two separate philosophical stances. These are that of structural objectivity (as outlined above), coupled to scientific realism, which claims that scientific theories are not just useful, but true in some sort of absolute metaphysical sense (Daston & Galison, 2010: 260–261) However, in practice, most scientists seem to take a somewhat more relaxed attitude to theorising than the above would suggest by adopting a flexible position, somewhere between essentialism and pragmatism, to arrive at what they feel are workable solutions (Jones, 2008). By doing so, they are effectively acknowledging that theories need to be treated not as permanent edifices, but as tentative and provisional frameworks for creating and assessing concepts and data; useful for now, but always likely to be revised and replaced eventually (Randall, 2011).[4]

One of the most enduring questions surrounding the methodology of science is still that of how to move from a series of specific observations to universal laws. Finding a unified description of the inductive logical and creative processes by which scientists arrive at and adopt such theories has turned out to be a surprisingly complex affair in practice (Feyerabend, 1993), prompting the question: 'How are we to reconcile the strictly literal elements of science required for dealing with the physical world with the more creative and imaginative aspects required for constructing new conceptual models and theories?' Questions of this nature must be addressed if we wish to improve our current understanding of how as humans we construct our notions of reality, and whether scientists are creating credible concepts and tools for interacting with the often illusive and intangible aspects of the world in which we live; as with dark matter and energy (Panek, 2011) or elementary particles (Baggot, 2012). Two areas in particular that may well hold the key for enquiring further into how our imagination and creative understanding of science is forged are Bayesian constructs and metaphors.

[4] If we accept that truth and falsity are contingencies of language and not properties of the physical world independent of the mental activities of humans, then in a narrow sense we can see how Rorty's comments that 'truth was made, rather than found …' (1989: 3) and 'The world does not speak. Only we do' (1989: 6) can apply to scientific theories. To make headway, scientists often adopt a blend of strict scientific realism tempered with a healthy dose of pragmatism, but they can sometimes be guilty of failing to make the distinction clear. In effect, they, too, are accepting that in some circumstances what we term truths are sometimes just useful 'Nietzschean' white lies that help us to describe the world in a more convenient form.

13.8 Bayesian Constructs

The weakness of traditional epistemology in dealing with questions of probabilistic knowledge and how we update our working hypotheses has forced researchers to look to the field of cognitive science for new thinking based on ideas first developed by Thomas Bayes in the eighteenth century. Bayes' early ideas relating to abstract concepts of probability and how we give credence to new, but possibly incomplete, information when updating our understanding of the world were refined by Laplace and then taken up and developed by Turing to help crack the German Enigma code in World War II (McGrayne, 2011). By this route, Bayes' ideas eventually found their way into neural learning networks and then into the fields of neuroscience and visual perception. Today, Bayes' approach has widespread practical uses in such diverse applications as spam filters, establishing optimal search and rescue patterns, and machine translation algorithms.

Human perceptions in general are now being viewed as a provisional hypothetical framework (or Bayesian construct) that we all unconsciously adopt to test incoming and usually incomplete sensory data for inconsistencies and to interpret for potential meaning (Dayan & Abbot, 2001). Normally, we remain unaware that we unconsciously treat perceptions as working hypotheses (i.e. informed guesses) that are modified and updated by additional new information and experience, but instead accept them as true and accurate representations of the outside environment provided by our eyes-as-cameras. However, just occasionally we perceive the struggle and the incompatible results that can be thrown up into our conscious world, as with optical illusions, for example. Sometimes, two entirely different hypotheses may appear to fit the data equally feasibly as with the ambiguous figures of Gastrow's duck/rabbit and Necker's cube. Here, our brains consider each of the two different possibilities in turn, giving us the distinct impression that we are jumping erratically between two alternative, yet equally valid, views of the world (Morgan, 2003: 97). As Ramachandran notes (2012: 57) when describing the question of vision and perception: 'It's as if each of us is hallucinating all the time and what we call perception involves merely selecting the one hallucination that best matches the current input'. That our powers of perception seem to involve such large doses of 'parallel virtual reality' is initially a disturbing thought for many people, who may have been brought up to 'trust their senses' implicitly.

Bayesian constructs also play a role in a related visual phenomenon that will be familiar to many practising artists – that of colour constancy. We are able to retain a continuity of colour sense within scenes even when they may be bathed in highly coloured illumination, as with strong sunlight causing deeply coloured shadow cast over a white shirt, for example (Parraman, 2014). The shirt still appears more or less white to us when seen in context, even where light with a widely different spectral distribution is involved. Scientific theories and their associated conceptual models can also be viewed as formalised versions of internalised Bayesian constructs, consciously and deliberately set up to make sense of our outside world experiments (Wilson & Sim, 2013). In the same way, these external theories and models need to

be treated as provisional ways of seeing the world and trying to make sense of it. Accepting that a degree of uncertainty in our theoretical framework naturally translates to a provisional view of the word would make us much more prepared to update or radically change our theories in the light of new or troubling information that does not conform to established patterns, as with dark matter and dark energy for example.

13.9 The Role of Metaphor in Science

Any knowledge claims formulated on the basis of uniquely mediated access to any form of external objective world will always come under challenge in postmodernity. Consequently, as scientists, we need to seek a way of explaining our theoretical understanding and experimental interactions with the physical world that is not based solely on privileged notions of absolute truth, but is defendable as the product of human reasoning without diminishing its rigour and usefulness as a tool of scientific enquiry. A promising point from which to start is that, while the internal deductive logic of science is clearly concerned with manipulating literal truth, the underlying conceptual models from which these predictions emerge are very probably metaphoric in nature (Wilson & Sim, 2015). Lakoff and Johnson's (1999) work on embodied realism, which links our powers of metaphor-infused thought and imagination to our sensorimotor faculties and experiences, helps us to appreciate why this may be so, and why non-literal modes of representation may be required even when dealing with literal truth conditions of the physical world.

The fundamental conceptual models that we construct for scientific theorising depend for their predictive powers as much on creating 'new ways of seeing' inspired by metaphors as they do on literal truth concepts for their usefulness. Since metaphors by their nature are open-ended rather than prescriptive, they are able to harness a greater degree of polyvocality and emergent possibilities when creating provisional conceptual models and intersecting notions of truth for the purposes of making testable predictions. An explanation of the usefulness of a theory based on a metaphoric structure does not relax any of the requirements for painstaking and detailed investigative work relying on stringent truth tests necessary from experiments performed in the physical world, but it does offer a richer and more inflected sense of understanding about how such viewpoints and information are both created and treated in relation to the physical world (Latour, 1993).

For those whose concern is more with the character of scientific knowledge itself, rather than the day-to-day practice of science, attempts formally to analyse conceptual models and their testable predictions raise a number of interesting questions relating to foundational assumptions. In particular, theories and their internal conceptual models have historically been evaluated together as one, using truth tests applied in the physical world. Such tests are indeed appropriate for judging the effectiveness of a scientific theory overall, but they are not necessarily the most suitable indicator of a conceptual model's imaginative utility. Addressing the less

clearly understood and far more subtle and complex cognitive processes by which humans perceive, categorise and represent their external world via internal conceptual models requires a more nuanced approach. While this latter aspect has previously received rather less direct attention in this context, contemporary philosophers of science are now much more likely to broaden their philosophical stance and look to adjoining disciplines (e.g. second-generation cognitive science, psychology, linguistic and critical theory) for inspiration and support in creating convincing theories of scientific knowledge able to withstand scrutiny from outside their own narrow field (Arbib & Hesse, 1986; Wilson, 2014).

13.10 Living Metaphors

Linguistic metaphors play a hugely important role in our verbal and written communications, not just in enriching the colour, tone and texture of our daily exchanges, but also as powerful and emotional linguistic techniques across the arts and humanities (Hagberg, 2005; Stafford, 1999). Poetry in particular has always leaned heavily on figurative language and the use of extended metaphors by eighteenth-century 'metaphysical poets' such as Donne created striking new perspectives (Gardner, 1966). It has become clearer over the last 50 years that our use of metaphors is not simply a background feature of the vernacular, but extends much deeper into the way we frame, describe and construct a surprisingly high proportion of our thoughts and fundamental concepts (Lakoff & Johnson, 1980: 6; Ox & Van der Elst, 2011: 83). Given the figurative mental scaffolding required for developing new theories in science, John Myhill's view (1952: 165) that: 'No non-poetic account of reality can be complete', offers us a useful reminder that scientific formalism should not be treated as a closed domain (Barrow, 2005: 215–216).

In *Metaphors We Live By*, Lakoff and Johnson not only demonstrate how the use of metaphors is widespread in daily speech, but also argue that, 'human *thought processes* are largely metaphorical' and that 'the human conceptual system is metaphorically structured and defined' (Lakoff & Johnson, 1980: 6). Evelyn Keller also notes that, 'as the ubiquitous presence of metaphor attests, the classic distinction between literal and metaphorical holds no better in scientific than it does in ordinary language', concluding: 'my assumption is that all language is performative' (Keller, 1995: xi). In other words, using metaphors is not just a passive form of description, but an active function that influences how we think and what we do. Indeed, Steven Mithen (1996) maintains that conceptual metaphors are an essential part of the mental toolkit that modern humans have evolved over their prehistoric ancestors to support abstract thought in general, and without which our imagination and conceptual plasticity would be severely constrained. Damage to certain areas of the brain can produce 'metaphor blindness', in which subjects become extremely literally-minded, while people exhibiting synesthesia (sensory overlap) are often particularly creative in their use of metaphors (Ramachandran, 2012: 105–106). However, science has only belatedly come to appreciate the role that metaphors play in creating

its own tools and constructing its distinctive way of seeing the world (Root-Bernstein, 2003).

Even the simplest and most obvious metaphoric expressions that operate as little more than extended similes display the one essential character that all metaphors share: they cannot be literally true (e.g. King Richard *is* a lion in battle; King Richard is human, not a lion) Similes do not create problems of truth conditions for the assertion, but metaphors clearly do. Metaphors are always *literally* false, but yet, true in some different non-literal sense that benefits our understanding and appreciation by offering a new (and possibly unexpected) viewpoint from which to contemplate the topic under discussion. More sophisticated use of metaphor – as in Shakespeare's comparison of Juliet to the sun; bringer of emotional life through her warmth, light and vitality, for example – still displays this crucial non-literal feature. It is evident that truth conditions become strangely irrelevant where metaphors are concerned. As Arbib and Hesse comment:

> Extended metaphors are not in that sense true or false, but are appropriate, or inappropriate, more or less revealing, more or less useful, depending on the context of application and their coherence with evaluative judgement made about particular situations. (Arbib & Hesse, 1986: 156)

Hagberg agrees (2005: 373), 'metaphoric expressions seem to propose a way of seeing the world, a distinct perspective upon it, rather than making a true-or-false assertion'. This suggests that a strict reductive tendency when analysing metaphor is misplaced, as metaphor is essentially a technique for travelling beyond what Wilson and Sim (2015: 35) term the 'logical event-horizon' of literal descriptive truth. This avenue of approach was strongly favoured by Black (1955), who held that metaphors are able to create cognitive insight through their novel conjunction of terms – terms which do not merely describe a set of already existing similarities within their ordinary contexts of our perceptual world. In effect, Black claimed that the cognitive value of metaphors cannot be reduced to a literal paraphrased equivalent without losing its unique impact and insight. Indeed, he maintained that the conjunction of associated ideas arising from each of the metaphor's terms may not even be 'sayable' using only the original component terms. Black's 'interaction view' effectively emancipated metaphors from the straightjacket of literal truth and opened the door to a creative study of the relationship between perception and cognition that is still underway today.

Lakoff and Johnson's work developed Black's interaction view of focus, frame and context even further by introducing the notions of target and source domains. Lakoff and Johnson (1980), among others (Ox & Van der Elst, 2011; Ricoeur, 1978; Rorty, 1989) contend that metaphors not only permeate our language but have percolated our thoughts to the unconscious level as well, to the extent that metaphors now underpin many of the concepts that we pre-reflectively take as literal. Lakoff and Johnson maintain that metaphorical content can hold true in that the cognitive content of the metaphor, in distinction to its literal meaning, can be considered valid by virtue of successful mapping from one domain of experience onto another. Their later work in particular (1999) argues strongly that our bodily experiences are a

uniquely powerful influence on our thought processes, providing virtually all of the domain content for one side of nearly all possible cognitive metaphors. '*Seeing* the point', '*illuminating* the problem', '*clouding* the issue', 'I don't *grasp* your meaning' and so on being usages drawn from the bodily experience of vision and touch projected onto the realm of pure cognition. Frequently, one layer of metaphorical description will stand not on literal fact but on yet another layer of metaphorical description that has become deeply set into our way of thinking. For example, to refer to the foundations of an argument is simply to employ yet another metaphor – this time architectural. Within this framework, what was previously recognised as a traditional metaphor is now considered to be only the surface linguistic manifestation of the deeper cross-domain conceptualisation (Lakoff, 1994) – the tip of the metaphoric iceberg, as it were.

The figurative language of metaphors and analogies clearly help scientists – and everyone else – to link experience, intuition and imagination when erecting conceptual scaffolding (an obvious metaphor, of course) for moving into new realms of the 'not-yet-known-or-experienced' where literal language on its own may be insufficient to fuel and sustain imagination (Wilson & Sim, 2013). A well-chosen metaphor is capable of creating understanding in a way that literal language often fails to do and can illuminate fertile new directions for study, until it is eventually accepted as the core of a predictive theoretical model. As highlighted by Brown (2008: 73), there are numerous historical examples of visual metaphors forming the basis of predictive models in the physical sciences, from Bernoulli's billiard-ball model of gases to the planetary model of the atom. Chemistry makes wide use of ball-and-stick models for molecular structures, along with the more comprehensive version built around space-filling chemical molecular models. No single model is ever intended as a complete description of reality and we are happy to employ different atomic metaphors to account for the physical and chemical attributes of physical matter. While a good choice of initial metaphor can offer a rich vein of experimental and theoretical directions, suggestions and explanation, these benefits eventually dry up if the metaphor becomes over-extended, as no single model is sufficient in practice to account for all the various observations that might conceivably be made. Our ability to explain experimental results then suffers and progress can falter until a new and more suitable conceptual metaphor is adopted and evolves into a new model or paradigm. Since no theory is ever expected to be universally applicable, as Hawking points out when discussing the nature and scope of M-theory (Hawking & Mlodinow, 2010: 8), then neither should we expect any particular metaphor to share that property. Indeed, one of the distinctive features of the use of metaphors is that they give us the ability (and perhaps even implied permission) to create models whose scope is accepted as being restricted, without resorting to special pleading for exceptions.

13.11 Scientific Theories as Metaphoric Equations

Acknowledging that, as scientists, our reliance on metaphors to create an interwoven mesh of literal truth and imaginative conceptual models is probably much more deeply infused into our unconscious than we previously realised suggests a novel approach to our understanding of scientific theorising. By offering a tentative transformational mapping between the embodied cognitive domain and the external physical domain, a scientific theory is essentially functioning as a metaphoric equation. In effect, it creates a virtual equation linking our internal mental schema of conceptual models and the external physical world of verifiable experiments via one or more falsifiable predictions from its associated mathematical formulation. The nature of the test is different on each side of the equation: metaphoric truth (such as unexpected insight) on the cognitive side; literal truth on the physical side. A scientific theory is a form of metaphoric equation in which an internal predictive conceptual model spontaneously offers multiple provisional metaphoric possibilities that need to be tested in the external physical world, where literal truth content can be determined experimentally. Each sustainable paradigm will therefore have at its core a unique metaphorically inspired conceptual model.

Metaphoric understanding helps to create and explore the provisional world of concepts, in contrast to the physical world in which we employ literal truth tests. A brilliant theory functions well in both domains and in doing so ushers in a novel paradigm through its new way of seeing. Lesser theories may well be literally true in a very narrow context, but never create a similar impact because the conceptual model employed does not overturn (or substantially challenge) a previous one to offer a new source of exciting conceptual and experimental possibilities. Scientific work in its most fundamental sense, therefore, will always consist of testing both metaphoric and literal truths in their mutual embrace across these two domains, never just the one element in its own domain. It follows that new paradigms are based on new conceptual models and a replacement paradigm cannot be based on the same metaphoric relationship as the old one it replaces. Kuhn's 'revolutions' in science are essentially metaphoric revolutions that create new theoretical landscapes (and language) for viewing scientific phenomena, both existing and as yet unimagined.

At one level, science functions by creating conceptual models to represent the natural environment for purposes of prediction and control. We generally perform these tasks by constructing models to satisfy pragmatic criteria expressible in locally stable language using deductive arguments to make testable predictions. However, the existence of periodic scientific revolutions suggests that we are unable to sustain these tasks exclusively within the domain of idealised literal language and truth conditions based on a simple correspondence theory of truth, but need recourse to a more creative and imaginative metaphoric domain as well. This is certainly not a rejection of scientific realism, simply the realisation that it may need extending to explain the puzzle of 'how models and theories are, after all, significant in some sense in indicating the real, even though they are not literally true of it' (Arbib &

Hesse, 1986: 158). A metaphorical view of scientific language still requires that, as before, we bring the language of theory and observation into sufficiently close alignment to permit convincing descriptions and explanations embracing a wide range of phenomena to emerge. However, we need to appreciate that the logical consistency and deductive rigour by which Kuhn's routine 'puzzle solving' of normal science is pursued are ultimately tools by which conceptual models are judged; not tools for creating them.

Once scientific metaphors – no matter how surprising or unexpected – are established as useful they are extended and developed by logic, as well as analogy. The development of quantum theory provides a useful example of a metaphoric reformulation that took decades to be resolved. Initially, both particle- and wave-based conceptual models seemed to be required to explain the range of known quantum experimental phenomena until Feynman's 'quantum electrodynamics' (1985) created a radical new range of language and concepts capable of replacing the two earlier incompatible models and offered new productive theoretical pathways for physicists to explore.

It has long been accepted that in practice scientific theories embrace more than just the literal dimension. Terms such as beauty, elegance and economy of expression have often been employed when attempting to list the features or desirable attributes of a good scientific theory, but having been mentioned once they generally disappear quietly from subsequent discussion (Hawking & Mlodinow, 2010: 51; Randall, 2011: ch. 15). This is unfortunate, given that they nearly always seem to play an obliquely acknowledged role whenever new scientific theories are argued over by the scientific community (Feyerabend, 1993). A scientific theory creates via its embedded conceptual models (and attendant mathematical predictions) both a standpoint from which to view the world and tests by which to evaluate its success. Hence, contemplating a scientific theory as a metaphorical equation helps to explain how such notions of beauty, elegance and economy of expression come into play as both part of the mapping process and components of the mechanism for adopting possible conceptual metaphors. In effect, these aesthetic terms are being used as synonyms when assessing the *fertile* possibilities that might be expected to follow from the adoption of a particularly *fruitful* (both obvious metaphors, of course) conceptual model. Routinely encountered phrases such as 'opens up a rich new vein of experimental possibilities', 'it elegantly combines two previously separate strands of work' and 'encapsulates several restricted earlier approaches through its economy of expression' are all ways of indicating and highlighting the open-ended promise of new theories based on an assessment of the conceptual model at their central core (*heart*).

When scientists become involved with 'public engagement with science' events, such as Brian Cox's and Jim Khalili's popular UK TV programmes, one of the characteristic features of their presentational script is an evident and conscious search for appropriate metaphors and analogies to relate the otherwise esoteric concepts and explanations into the everyday world of a lay audience. As such presenters are aware, a good grasp of the outline working of many scientific topics can be gained through the use of metaphor and analogy, although detailed predictions cannot be

made without recourse to complex maths. However, the use of metaphoric language goes further than simply acting as a conceptual lubricant for public understanding of science. Science, when viewed as a broad socio-epistemic stance, also offers a narrative discourse that extends far beyond the confines of its routine 'predict and control' algorithms in respect of the physical world (Broks, 2006); it represents a unique and distinct way by which the world is to be experienced and interpreted, and by doing so cannot avoid going head-to-head with other fundamental ideologies, such as religion – and all such arguments are fought using emotionally-charged figurative rather than literal language.

Fundamental scientific research is not simply a treasure hunt for pre-existing knowledge-objects, conveniently embedded like gems in some form of theory-neutral cosmic setting, but is crucially dependent on the cognitive frameworks and conceptual models that we create for interacting with the world. As Einstein pointed out on several occasions, 'I am enough of an artist to draw freely upon my imagination. Imagination is more important than knowledge'.[5] Without *a priori* cognitive and linguistic frameworks of one form or another, we cannot know anything definite about the external world or undertake detailed experimental work. All we receive is a stream of unstructured sensory impressions that the brain struggles to make sense of by creating its own tentative and provisional interpretive frameworks, probably in the form of Bayesian constructs, as already discussed. Kant maintained that we cannot make theory-neutral observations; a point echoed by Einstein when he stressed that, 'It is the theory which decides what we can observe' (Heisenberg, 1971: 63). The new quantum world that Bohr, Einstein, Heisenberg and Schrödinger argued fiercely about in the 1920s was not simply discovered as a self-contained and ready-packaged entity; it took many world-class scientists decades to create and refine the conceptual models required to make sense of it (Kumar, 2008). Echoing Martin Kemp's comments on gravitation (2006: 78), the quantum world as we understand it today is just as much a crafted product of human imagination as it is a physical one. At the extremes of scale encountered in particle physics and cosmology it takes a great deal of imagination, not just technology, to render the intangible visible (Elkins, 2008).

Metaphors can be both pervasive and subtle in relation to how we create and think about science's underlying conceptual models – models that in effect help us to construct our fundamental sense of scientific reality. They have become widespread in the biological sciences, with immunology leaning on them particularly heavily: for example, medicine as a war against disease, with the immune response as the first line of defence being a widespread figurative choice. Combat metaphors are not the only ones used in immunology, but they are certainly among the most prevalent, extending from popular accounts of immunology right through to medical textbooks and research papers (Napier, 2003).

[5] Remarks made during an interview with George Sylvester Viereck that appeared in *The Saturday Evening Post* (Indianapolis, IA) 26 October 1929. Very similar phrasing also appears in Einstein's own 1931 book: *Einstein on Cosmic Religion and Other Opinions and Aphorisms*, reprinted in 2009 by Dover Publications (Mineola, NY).

Accepting that it is almost impossible to think or write about science without using metaphors should make us cautious about the ones that we do employ. As metaphors can seriously affect how our understanding is channelled, they also have the potential to fail or mislead us through their more subtle entailments (Root-Bernstein, 2003). For example, how does the dominance of the self/non-self idea in immunology affect societies' wider attitudes to illness in general? – or blind us to other avenues of potentially useful developments in immunology? Metaphors in science are indeed helpful, but they are not culturally neutral figures of speech, and can hold back the science either directly (because an unproductive path is followed) or indirectly (because alternative paths are not explored). Metaphors based on clocks and telegraph wires from a century ago may have been replaced today by ones based on cybernetics, information theory and computers, but they still play similar roles in how we formulate scientific concepts and research programmes. As Evelyn Keller suggests in *Refiguring Life*, our earlier, culturally based gender-stereotyping of the active male sperm penetrating a passive female egg probably delayed work on how the egg actively participates in the process of fusion and fertilisation (Keller, 1995: xii–xiii). Similarly, growth of a new generation of research programmes in developmental dynamics (many associated with stem-cell research) may well have been encouraged partly because the Human Genome Project indirectly brought about a rethink to the earlier deterministic image of Dawkin's 'selfish genes' as all-powerful causal agents (Keller, 2000: 5–8).

The traditional approach to epistemology deals only with certain knowledge, making it incapable of recognising suspicion, doubt, uncertainty or 'maybes' that form such a valuable part of the everyday sleuthing kit that we all employ as scientists when investigating puzzling or unexpected information. In contrast, Bayesian epistemology accepts that learning does not usually come in the form of certainties, but in the form of information that must be weighed and assessed in order to update our notions. Bayesian calculus enables us now to explore quantitatively how our credence in a proposition or model is affected by new information when we attach varying degrees of belief to the new evidence (Hájeck & Hartmann, 2010). This is just the position we are likely to find ourselves in when working in a new and developing field and trying to organise notions, structure revealing experiments and analyse emerging information. At this stage, it is not unusual to be working with 'probable knowledge' gleaned from experiments structured on the basis of competing conceptual models based on differing metaphors and clues producing noisy, inconclusive and often ambiguous data.[6]

In its broadest sense, scientific work therefore consists of testing both metaphoric and literal truths together, never just the one. The metaphor-inspired conceptual model creates multiple testable predictions stemming directly from a particular way of viewing the world, backed up by detailed experimental science to seek

[6]The notion and characteristics of probable knowledge will be very familiar to practitioners of crossword and codeword puzzles, where tentative solutions to multiple intersecting words must be juggled against other possibilities until a pattern is found that simultaneously satisfies all constraints.

verification of the falsifiable predictions. The metaphorically inspired side is always implied, even when it does not explicitly appear in accounts focusing on logic and mathematical formulation, since all new conceptual models are built by adopting a different metaphoric viewpoint.

The two related domains of the metaphor straddle both sides of our sensory boundary: the cognitive domain is internal, whereas the confirmatory experimental domain is external to us in the physical world (although a range of 'thought experiments' are often employed when constructing or contemplating a new model). Demarcation between the two domains depends to some extent on how we view the boundary between self and non-self; whether we adopt a disembodied Cartesian object/subject dichotomy or one based more on a form of embodied realism. The former results in a sharp separation between the two domains, whereas the latter creates a rather more diffused notion of self that can be linked to its physical, social and ecological environment (Guattari, 2008), leading to a more subtle form of embodied scientific realism potentially capable of embracing aesthetic judgements as well (Wilson, Sim, & Biggs, 2016). It is tempting to suggest that a deeper understanding of the role of metaphor and figurative language in general may also offer a means of remediating the relationship we have constructed between ontology and epistemology: between what is and what we can know through our theories of knowledge and the conceptual filters that colour our view of the world.

13.12 Conclusions

This chapter has explored how an embodied aesthetic for ArtScience could be conceptualised, were we to replace Descartes' framework of disembodied realism with one based on an embodied approach more in tune with the digital age and advances in second-generation cognitive science. The attendant notions of moral and ethical considerations within such an embodied aesthetic would displace the current neoliberal 'rational-actor' model and resituate ArtScience firmly within a social context so that complex questions may be legitimately framed, acknowledged, discussed and decisions arrived at through more inclusive processes built around forms of public participation. For this to succeed, we need a way of understanding and representing technoscience that accommodates it within the human and societal dimensions rather than separating it – and this is where the proposed embodied aesthetic discussed in this chapter is particularly important. A more inclusive and informed decision-making framework of this nature is surely required to address increasing public concern over the manner in which important national projects are handled, GM food-crops, fracking, HS2 rail line and Hinckley Point 'C' nuclear power station being recent UK cases in point.

New insight into how scientists, or any practitioners, reconcile creative conceptual models and literal truth in daily practice can be gained by viewing a scientific theory as a form of metaphoric equation linking our mental and physical worlds together: conceptual insight on one side of the equation and literal truth on the other.

The role of metaphor in science is primarily as a mechanism for tentatively proposing and examining novel and provisional ways of viewing the world when trying to establish productive ways of approaching previously unknown or never-experienced problems or re-examining already known troublesome inconsistencies. It does so by offering us a non-literal conceptual mechanism for assessing the creative usefulness of linking different experiential or conceptual domains in order to gain traction for eventual action in the real physical world. All new theories start out as provisional, because metaphors all offer multiple tentative possibilities that require exploration and testing in the physical world to determine the extent of their usefulness. A replacement paradigm will always exhibit a different metaphor and associated conceptual model at its heart from the one it has replaced. Bayesian epistemology offers a valuable tool designed to handle uncertainty and probabilistic knowledge, supporting the role metaphors offer us as ways to navigate successfully from novel insights, tentative possibilities and ambiguous experimental outcomes to a state of stable knowledge, routinely repeatable experiments and mass-produced consumer goods.

We all readily use and respond to metaphors and general figurative speech in our everyday personal, social and intellectual environment and are quite happy to accept that metaphors somehow live outside the ordinary rules we usually employ for rational logical analysis. It now looks increasingly likely that this also holds further and deeper into our professional lives than we realised, and is a necessary and fundamental part of the way that we humans imagine our worlds when trying to construct the literal knowledge that is essential when undertaking such tasks as life-saving surgery, operating a complex power plant or launching a space probe.

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Chapter 14
We Have a Choice: Transdisciplinary Research or Action Research for a Professional Doctorate Research Programme?

Ifan D.H. Shepherd

14.1 Introduction

Not so long ago, almost the only option available for a doctoral research student was the academic PhD. In recent years, however, a number of significant alternatives have emerged in the research degree marketplace, among them the industrial PhD, the team-based doctorate and the professional doctorate. At the same time, a number of alternative research frameworks, approaches or paradigms have emerged, and these are currently in competition with one another for research funds and research students. Among the many options co-habiting a rapidly evolving research landscape are: data science (Foreman, 2013; Galison & Hevly, 1992), holistic inquiry (Barber, 2006), team science (Stokols et al., 2008a, 2008b), collaborative research (Anaquot, 2008; Katz & Martin, 1997), participatory research (Bergold & Thomas, 2012); integrative science (Hoffman, Sherrick, & Warm, 1998), inter-sectoral research (Roy, 2000), translation science (Titler, 2004) and several others. These are in addition to the three standard varieties of cross-disciplinary research: multidisciplinary, interdisciplinary and transdisciplinary (Jantsch, 1970; Rosenfield, 1992). Some of these approaches have a tight fit with specific fields of study and/or practice, while others have broader relevance. In addition, some are better suited to mainstream scientific research, others are more suited to applied research and yet others are supportive of various blends of the two.

Transdisciplinary researchers have for some time been making conceptual and operational alliances with other forms of collaborative and cross-boundary research. For example, affinities have been drawn between transdisciplinary research and team science (Croyle, 2008; Hall, Feng, Moser, Stokols, & Taylor, 2008; Hays, 2008; Mâsse et al., 2008; Shen, 2008; Stokols, Hall, Taylor, & Moser, 2008a; Stokols, Misra, Moser, Hall, & Taylor, 2008b; Syme, 2008); between transdisciplinarity and

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systems thinking (Leischow et al., 2008); between transdisciplinary research and collaborative research (Emmons, Viswanath, & Colditz, 2008); between inter- and transdisciplinary research and cross-sectoral research (Shen, 2008). Stokols (2006) has even gone so far as to propose a fusing of transdisciplinary research with action research, under the banner of transdisciplinary action research.

It is becoming increasingly important for doctoral students to choose carefully between the available approaches to research, not only for the successful completion of their projects, but also for their future career prospects. Equally importantly, doctoral programme providers need to consider which of the alternative approaches they are able to support, so they can put in place the necessary training, research facilities and supervisory staff for students entering their programmes. Unfortunately, there is little dispassionate information on the distinctiveness of these inhabitants of the contemporary research landscape, and of the relationships and overlaps between them. There is also little systematic information available on the comparative merits and demerits of these approaches as vehicles for doctoral research projects. This chapter therefore represents an attempt to fill this research gap by comparing two contrasting approaches: transdisciplinary research (TR) and action research (AR).

At Middlesex University Business School where I work, we already offer one academic doctorate (the PhD) and two professional doctorates (the Doctor of Business Administration (DBA) and Doctor of Professional studies (DProf)), and these are positioned carefully with respect to distinct student market segments. We also position our two professional doctorate programmes in the marketplace in comparison with similar offerings from other competing business schools. Having adopted an AR approach for all professional doctorate student projects since 2010, a recent revalidation exercise has afforded the opportunity to assess whether an alternative approach would be preferable for future research projects undertaken on these programmes.

The current chapter therefore attempts to compare the relative merits and demerits of TR and AR as organising frameworks for our professional doctoral students. This comparison does not use metrics gathered from previous cohorts of students who have adopted AR, because similar metrics are not available for students using TR on our programmes. Instead, the comparison will be based on a recently undertaken extensive literature review of TR that matches one undertaken previously for AR. These reviews will enable the relative merits of both approaches to be compared on a like-for-like basis. Readers will hopefully be able to judge for themselves whether the inferences drawn from these sources are justifiable or not.

14.2 The Professional Doctorate Research Project

The professional doctorate students who undertake their doctoral research projects at the Business School are all full-time professional practitioners. They enrol on a 4-year part-time programme that is studied by distance learning. They submit a research proposal at the end of their first year, and then undertake their research

project over the next 3 years. Their projects are all practice-based, and typically focus on in-company interventions for which they are responsible as senior managers. Students are recruited so as to match these two research characteristics. The stakeholders of our students' research projects consist mainly of others who work in their organisation, whether in senior executive positions, in horizontally equivalent managerial positions in other departments or divisions and/or other employees whom they manage. External stakeholders may also need to be considered during their projects, including company investors, clients and/or customers. Strictly speaking, our doctoral researchers are neither academics nor professionals, participating as specialists in a team-based collaborative venture. Rather, they are solo practitioner–researchers, and gradually evolve a hybrid mindset. For most of them, an initial emphasis on professional ways of thinking decreases as their projects progress, and they increasingly embrace academic ways of thinking and researching.

14.3 Pen Portraits of TR and AR

Broadly speaking, there are two main styles of TR.[1] Stokols et al. (2003: S21) provide the following definition of the style of TR, which focuses primarily on a scientific agenda:

> Transdisciplinary science (TDS) involves the integration of theoretical and methodological perspectives drawn from different disciplines, for the purpose of generating novel conceptual and empirical analyses of a particular research topic.

In contrast, Hirsch Hadorn et al. (2008: 19) refer to the more applied style of TR as 'a form of research that is driven by the need to solve problems in the life-world'. This is further elaborated by Pohl and Hirsch Hadorn (2008: 113):

> In transdisciplinary research, scientific disciplines… and sectors of the real world… are getting interrelated and transformed through a problem field. A transdisciplinary research project is the system built by the collaborative research process.

Since our professional doctorate research projects may be considered as forms of 'problem solving' within organisations, the latter definitions are perhaps more germane to the current discussion. In a typical applied TR project, academics are brought in to assist in resolving a specific problem, and are joined by other participants who bring their own strengths to the table. Clients bring their intimate knowledge of the social or organisational context, which is typically non-academic in character, their access to key levers of change, and so on. For their part, academics bring experience in applying research methods, not only in helping to resolve the problem at the heart of the project, but also in extracting actionable and other forms of knowledge from the working partnership.

[1] For a broad overview of the shifting conceptual landscape of transdisciplinarity, see Klein (2008).

As the term implies, AR is concerned with research that is integrated with finding solutions to problems in specific contexts. Piggot-Irvine and Zornes (2016) have noted AR as having the following underpinning characteristics: 'collaborative, consultative, democratic, reflective, reflexive, dialogical, and improvement oriented'. AR projects usually involve four clearly defined phases: diagnosis, design, implementation and evaluation. (A separate reflection phase is also sometimes included.) These comprise an AR cycle, which may be repeated through the lifetime of a change project in order to converge on a suitable problem solution. All AR solutions are ultimately regarded as provisional only.

In the classic version of action research, commonly known as participatory (PAR), a researcher or research team engages with a stakeholder/client or stakeholder/client team, and work together on resolving an agreed problem (Coghlan & Brydon-Miller, 2014). Although AR projects can be catholic in terms of the sources of concepts, theories, research approaches and methods that are harnessed by the practitioner–researcher, the deep integration of knowledge from multiple disciplines does not have as high a priority as in TR projects. In addition to providing solutions to real-world problems, AR projects usually generate actionable knowledge, that is, knowledge that has practical uses in related circumstances. Most mainstream AR is practised by those who espouse a purist adherence to interpretive research methods, and an objection to conventional definitions of research rigour. In contrast to disciplinary approaches which place a premium on theory – either the testing of existing theories or the creation of new theories – AR is equally comfortable with producing procedural rather than declarative knowledge. While knowledge gained through AR is often situation bound, this is no different from many of the applied TR projects, nor is it very different from a great deal of the supposedly generalised knowledge emanating from conventional academic research projects.

It should be noted that there are several similarities between most AR projects and applied TR projects. For example, the project focus and agenda are typically located among non-academic 'actors', that is, on the clients' or stakeholders' home turf. In both cases, there is also considerable collaboration among teams of experts. As we will show later, however, significant differences emerge in the special case of our professional doctorate students.

In the subsequent sections of this chapter, TR and AR will be compared in relation to a selection of key distinguishing characteristics. Each of these will be introduced from the perspective of TR, and their suitability will then be judged in relation to AR. Following these comparisons, an attempt is then made to answer a key question arising from the nature of our professional doctorate students, and conclusions will be drawn at the end of the chapter as to which approach is preferred.

14.4 Complexity and Systems Thinking

One of the founding claims of a transdisciplinary approach is that it is essential for confronting complexity[2] in the real world (Morin, 1992; Nicolescu, 2010). In contrast to single discipline approaches to research, which typically dissect the real world into discrete issues, a transdisciplinary approach is better able to address the complexity of reality by analysing it from multiple perspectives. This applies whether the research project is examining some element of the real world in order to understand it, and produce coherent knowledge as an outcome, or whether it is part of an applied project where an equally important goal is to solve a complex problem in (say) the socio-environmental domain. Systems thinking is therefore closely allied to the transdisciplinary mission of confronting complexity.

Claims for the paradigmatic status of systems thinking in relation to complexity were made from the 1970s by Morin (1992, 1994, 1997) and Jantsch (1970: 405), who suggested that 'a certain danger may be seen… in the temptation to… neglect the systemic character of most of the[se] problems in the social area'. There are also several references in Rosenfield's discussion of TR to the importance of systems-based modes of thinking about health problems (Rosenfield, 1992; see also Higginbotham, Albrecht, & Connor, 2001). Many applied transdisciplinary projects involve the co-creation of a conceptual systemic model by project participants, which occasionally result in a formal systems diagram (e.g. Lawrence, 2004). However, the principles behind this form of inquiry are not fundamentally new. In the author's original discipline of geography, for example, there was a phase during the 1960s and 1970s, entirely unconnected with the emergence of transdisciplinarity, when the discipline wholeheartedly adopted the systems approach to understanding the real world through modelling and simulation (Anderberg, 2004; Chorley & Haggett, 1967; Huggett, 1980).

Because our professional doctorate students will be researching their own change-related practices in their workplaces, our review of complexity in relation to AR necessarily focuses on its organisational context. Complexity is not always associated with large-scale entities or systems. Indeed, organisations in which our professional doctorate students work may be both small and complex. One chief executive officer respondent to a recent business organisation survey suggested that the phrase 'too big to manage' should be replaced by the phrase 'too complex to manage' (Economist Intelligence Unit (EIU), 2015: 3). It is also increasingly recognised that complexity cannot be addressed simply by attempting to suppress it, or by applying standard management techniques – including systems analysis – to manage it. Rodgers (2013: 1) expresses the problem as follows:

> Life in organisations is unavoidably messier and more uncertain than the formal strategies, structures, systems and processes imply. And yet most discussions of organisational management and leadership practice remain firmly rooted in mainstream presumptions of certainty, predictability and control.

[2] Nicolescu (2007) relates complexity to the older concept of universal interdependence.

Keskinen, Aaltonen, and Mitleton-Kelly (2006: 14) express a similar sentiment: 'there is less certainty, rationality and possibility for control, but greater complexity in those settings where strategic decisions are made and implemented, than usually described.' In order to effect change in an organisational world, complexity has to be addressed. As Collins (1998: 195) puts it: 'understanding that the social world is inherently complex and difficult either to comprehend or manage, must be the first step to understanding what can be.'

While a systems approach might be appropriate for analysing phenomena in the natural world (though many, such as the weather, are not only inherently complex but chaotic), in and of itself such an approach is insufficient for understanding and managing organisational 'systems'. What, then, can AR contribute to understanding and managing organisational complexity? Argyris and Schön have suggested that a purely technological approach to management needs to be tempered by an approach that recognises an epistemology of practice among professional managers, and that managers must incorporate deep and continuing reflective practice when undertaking organisational change (Argyris & Schön, 1974, 1978; Schön, 1987, 1995). A related approach proposed for dealing with organisational complexity is to view organisations not only as social systems, with their own cultures and political processes, but more fundamentally as 'dynamic networks of self-organising conversations' (Rodgers, 2013: 5). Change agents (typically senior executives) have to recognise that 'every conversation is, in effect, a co-creation forum. And, as a further sobering thought for managers, the vast majority of these conversations take place in their absence.' (Rodgers, 2013: 6). Consequently, formal managerial approaches and systems thinking are unlikely to contribute to a full understanding of how people are behaving in line with the stated mission of the organisation, and how best to foster required change. Nor will organisational change succeed if the conversations of a wide range of stakeholders are not embraced in the action research project. In the final analysis, however, the results of the changes that action researchers seek to implement in may be subject to a degree of unknowability. As Rodgers (2013: 22) puts it:

> It isn't possible to link specific interventions to organisational outcomes – either before or after the event. Nor is it possible to carry out 'experiments' in limited settings and expect the repeatability and/or scalability of these to be unproblematic. The complex social dynamics of organisational life make the relationships between cause and effect untraceable.

AR can provide a suitable framework for professional doctorate students undertaking action-oriented research in their own workplaces. This is encouraged by its adoption of a catholic approach to harnessing research approaches and methods in a context of change-related projects, by its integration of reflective practice through the multiple phases of individual AR cycles, and by its iterative approach to designing and resolving organisational problems. Using AR, students are more likely to co-create a systemic view of complexity through interaction with internal workplace participants than through a more formal and detached form of systems analysis, especially when imposed from above or from outside.

14.5 The Unity of Knowledge

With a disciplinary background in theoretical physics, Nicolescu (2005) took as his starting point to defining TR the early twentieth-century realisation that all knowledge of the world is indivisible, and can only be truly acquired through studies which cut across what he refers to as the multiple levels of reality. Arguing that disciplines tend to compartmentalise knowing and the search for knowledge, he called for studies that not only ranged across several relevant disciplines, but also transcended their boundaries. In the place of fragmented disciplinary knowledge he proposed an approach which unites not only the hard and soft sciences, but also the arts and the humanities, and also embraces the knowledge and faith systems of religion and spiritualty (Nicolescu, 2007). He therefore proposed that a primary goal of transdisciplinarity should be 'understanding of the present world, of which one of the imperatives is the unity of knowledge' (Nicolescu, 1997). In order to achieve this, he drew on ideas discussed by Jean Piaget (1972), Eric Jantsch (1970) and others to develop a transdisciplinary methodology which he believed was necessary to achieve this unity (Nicolescu, 2010; see also Hirsch Hadorn, 2009). Some of the processes necessary to achieve cognitive integration appropriate for TR have been explored by Burger and (2003) and Hinkel (2008). However, despite the goal of the unity of knowledge achieved through what describes as a process of going between and beyond disciplines,[3] he has emphasised that disciplinary knowledge is not displaced when a transdisciplinary approach is adopted: 'There is no transdisciplinarity without disciplinarity.'

For AR, the unity of knowledge is a less evident goal. Rather, AR proponents emphasise the need for knowledge to be generated and owned not only by those who are trained researchers, but also by those whose working practices are likely to be impacted by organisational change brought about by ameliorative or performance-enhancing research projects. Multiple sources and kinds of knowledge, including tacit as well as explicit, and abstract as well as practice based, are then combined for the purposes of developing agendas for change that reflect the organisation as experienced as well as measured. In common with many applied TR projects, participative AR projects tend to be located outside academia, and their agendas are similarly developed on the basis of participatory investigations. In both cases, the unity of knowledge that may be sought for scientific purposes is accompanied by the development of integrated theories and cognitive models which feed into the resolution of real-world problems. In contrast, to the knowledge generated by academic researchers (from PhD students to full-time academics), which tends to subscribe to an epistemology of possession, much of the new knowledge that our professional doctorate students' projects generate is located within an epistemology of practice, which derives from the organisational context in which the action-oriented research takes place (Cook & Brown, 1999; Schön, 1984).

[3] '*Transdisciplinarity* concerns that which is at once *between* the disciplines, *across* the different disciplines, and *beyond* all discipline' (Nicolescu, 2007).

14.6 Societal Problem Solving

Although TR in the 1990s was perhaps more concerned with advancing scientific knowledge, its social problem-solving antecedents can be traced back to the ideas of Jantsch in the early 1970s (Jantsch, 1970; Klein, 2014). Despite the welcome gravitation of TR towards applied projects in more recent years (Brown, Harris, & Russell, 2010; Hirsch Hadorn et al., 2010), Penker and Muhar (2015) suggest that much of this research has developed in almost complete isolation from the long-established tradition of academic involvement in practical problem solving. Indeed, these authors suggest that TR has failed to learn from these antecedents, despite the fact that their principles could have added materially to the effectiveness of applied TR projects. These antecedents not only include the applied sciences, but also the world of academic consulting, where scientific interests meet and accommodate professional requirements. In these arenas, practical problems rather than disciplinary objectives become the focus of the research, and academics frequently prioritise problem solving and the application of theory to practice (and, occasionally, to money making) over the development of theory.

AR has been problem-oriented as well as theory-oriented from its earliest conception by Lewin (1946) (Adelman, 1993), and so provides an ideal fit with research projects whose primary objective involves changing the world, or some small part of it. AR projects therefore contrast with a large proportion of PhD projects which aim to explain the world as it is, rather than understanding the world by changing it. They also contrast with applied TR projects in that AR the researcher is usually a direct agent of change, whereas in TR the researcher may frequently help devise plans for change but not actually be involved in undertaking that change themselves. Unlike classic TR, AR does not impose an *a priori* requirement that practitioner–researchers should have expertise in multiple disciplines, and therefore able to contribute to transdisciplinary thinking. As with many applied TR projects (e.g. Brown et al., 2010), the main requirement with AR projects is a clear problem focus, and a mindset that is oriented towards the acquisition of knowledge that might help in resolving the problem at hand, wherever it may be found, both within and outside disciplinary knowledge structures.

14.6.1 Collaborative and Participatory Research

In recent years, published accounts of TR have increasingly focused on questions of teamwork, to the extent that collaboration has become almost a de facto definitional characteristic of this research approach. Because the generally accepted model of TR is for academics and others to work together in teams (a characteristic shared with many AR projects), effective cross-team collaboration is a key challenge of most projects. Penker and Muhar (2015: 139) suggest that 'stakeholder integration is a focal topic associated with transdisciplinary projects', and Fiore (2008: 251)

makes the point even more forcefully when he states that 'interdisciplinary research is *team* research'. Earlier studies of cross-disciplinary and cross-organisational multidisciplinary research have shown problems in balancing innovation gains against the coordination costs of such research (Cummings & Kiesler, 2005), and several studies refer to problems of multi-individual and multi-team collaboration TR projects (e.g. Hall et al., 2008; Stokols et al., 2008b). Stokols (2006) goes as far as suggesting that the success or otherwise of TR is bound up with the effectiveness of the collaboration between participating individuals and teams in undertaking combined research projects. To this end, he distinguishes between three types of collaboration that require facilitation in TR projects: among disciplinary researchers, among researchers and community practitioners, and among community practitioners. Gray's (2008) study of the leadership qualities required by TR project leaders, further distinguishes between cognitive, structural and processual tasks. Similarly, Augsburg (2014) has identified a number of attributes of successful TR project participants, including: the ability to accept different levels of reality; openness to alternative views; willingness to transgress existing boundaries; willingness to learn; and an aptitude for creative enquiry.

Since collaborative research involving large research teams are not unique to TR projects, TR researchers can benefit from lessons learned in other collaborative interdisciplinary studies. Many of these have also concluded that successful research collaboration is very difficult to achieve, and that collaboration difficulties can limit the anticipated research outcomes. For example, Bruce, Lyall, Tait, and Williams (2003: 459) suggest that, in the context of research projects funded under the European Fifth Framework, 'interdisciplinary integration involves intellectual and practical challenges and may thus be more difficult to achieve and hence less common than multidisciplinary research'. More recently, in an interim evaluation of US-funded transdisciplinary centres into tobacco use, Stokols et al. (2003: S32) reported 'early tensions' and 'clashes' between participants from various disciplines, exhibiting what Campbell (1969) had earlier referred to as 'departmental ethnocentrism' and what Becher and Trowler (2001) have more recently referred to as 'academic tribalism'. Although Stokols et al. (ibid.: S33) reported that, as their project proceeded, 'these early cross-disciplinary tensions have given way to greater tolerance', in their interim evaluation of the project they expressed concern that the prolonged phases of disagreement meant that 'the eventual research outcomes… may not yield grand, vertical integration across multiple levels of analysis' (ibid.: S36).

AR projects also typically involve participatory engagement in problem solving and knowledge generation. However, the formation of large AR teams is not a *sine qua non* of this research approach, despite the impression given by leading textbook titles (Chevalier & Buckles, 2013; Kindon, Pain, & Kesby, 2007; McIntyre, 2008; Reason & Bradbury-Huang, 2013). Even when there is a single primary researcher, whether they are an outsider academic or an embedded professional, they will inevitably and preferably develop multiple means of engaging with internal (and sometimes external) stakeholders at the organisation within which they are undertaking their change-related project. One of the more intractable problems facing

participatory AR, especially where a solo embedded researcher is involved, is that a change agenda may already have been drawn up, or at least approved by senior management. This inevitably implies a reduced scope for internal participants to collaborate in setting the project's main aims and objectives with the researcher.

14.6.2 Values and Ethics

One of the key principles of contemporary TR, especially in a social problem-solving context, is that the values of the individuals and groups with whom the researchers are collaborating need to be respected and valued. This is not just a moral issue, nor merely taking care to avoid culture clashes during a collaborative project. A multi-values approach is also essential if a suggested solution that arises from a project is to be successfully translated into action by the people with whom it is being devised (Dyball, 2010; Lawrence, 2010).

In our own practice-based AR projects, because the practitioner–researchers undertake change-related projects in their own workplace, it is a requirement that any ethical issues that arise during the course of these projects must be identified and managed explicitly as an integral element of their work. Moreover, these issues must be problematised and discussed in their theses. Some kinds of ethical issues are more likely to occur during AR projects than TR projects (Gelling & Munn-Giddings, 2011). For example, power relations can become problematic when a practitioner–researcher also has line management authority over colleagues. This can be especially difficult when these colleagues' working practices may be changed by the planned change programme that their manager has been tasked to introduce from above, and even more fraught when some of these colleagues are participating closely with the researcher on the project.

14.7 Are Solo Forms of Transdisciplinary and Action Research Feasible?

Most of the issues discussed so far crystallise into one central issue: the solo researcher status of our professional doctorate students. There are two key challenges which they would be likely to face, were they to be required to undertake a TR project. The first problem concerns the cross-disciplinary grounding necessary to undertake the conceptual integration that is commonly defined as a key characteristic of TR. This grounding actually presents the research student with a dual challenge: becoming knowledgeable about multiple disciplines, and becoming adept at ensuring creative fusions among those disciplines.[4] Most doctoral researchers at my

[4] This is related to the classic 'T' model of capability (Bannerman, 2003; Guest, 1991), which is widely favoured by recruiters in the creative industries.

university would feel browbeaten at the prospect of having to master Max-Neef's (2005) system of levels. Career academics who adopt interdisciplinary and transdisciplinary approaches to their individual research typically have to consider only a small number of related disciplines, and acquire their familiarity over a considerably longer period of time than is available to the typical PhD, DBA or DProf student. In contrast, almost all professional doctorate students I manage are senior managers whose previous academic experience was many years in the past, and was typically confined to a single discipline.[5]

The second, and related, challenge that would confront our solo researchers if they undertook a TR project is that it would most likely involve their participation with one or more teams of collaborators. Teams are often essential because of the large scale, broad scope and/or complexity of the problems being addressed, which requires multiple disciplinary perspectives from academic partners and alternative perspectives from non-academic partners. Team-based research is characteristic of TR undertaken to solve real-world problems (e.g. Brown et al., 2010), as well as in TR undertaken with a primarily scientific focus (Cooke & Hilton, 2015; Mâsse et al., 2008), and is often prioritised by major funding agencies. As has already been indicated, collaboration places considerable demands on participants in TR projects, and requires considerable training beforehand, and considerable time and effort during the project itself.

Because of the need to incorporate considerable cross-disciplinary knowledge in order to build a unified knowledge base, TR projects usually require a team-based approach, often involving multiple academics. In AR projects, in contrast, the involvement of external academics is typically reduced to a single individual: the student's academic adviser. The most likely team involvement involves staff internal to the organisation. The emphasis seen in AR projects on the participation of academic staff is therefore reversed in our professional doctorate AR projects, where there is instead a bias in favour of professional participants. In simplified terms, the team basis of TR and AR projects stems from contrasting principles. With TR as originally formulated, teams were required to combat knowledge fragmentation by ensuring the adoption of cross-disciplinary and other knowledge perspectives. With AR, as is also the case with applied TR, research teams are assembled to engage those people who are most likely to be affected by its outcomes.

14.8 Which Research Approach Is More Appropriate for Our Professional Doctoral Programmes?

Our professional doctorate research projects have three significant characteristics: they are practice based, undertaken by professional practitioners who are embedded within an employing organisation; they involve organisational change that brings

[5] Those having taken a broad-based MBA are perhaps partial exceptions to this rule.

benefits in terms of improved business performance; and they are undertaken individually by the students, working as solo practitioner–researchers. This last characteristic is related to the degree regulations at my institution, which require that our professional doctorate awards are made to individual researchers, not to research teams. A key question is whether a sole practitioner–researcher can become knowledgeable enough about several relevant disciplines, and also be sufficiently adept at creating creative fusions of these disciplines, in order to meet the knowledge-generating requirements of the canonical forms of TR?

Some transdisciplinary researchers believe that individual researchers are indeed able to engage in TR. Nash (2008, quoting Davidson, 2008), for example, argues that individual scientists can be integrative across disciplines in their research projects. Adams (2006: 516) suggests, without further elaboration, that in health education research, 'TD science does not necessarily need to be conducted by a team. There are individual scientists who conduct TD research, embracing other disciplinary perspectives into their work.' Another statement in favour of the solo transdisciplinarian comes from Stokols et al. (2003: S22), again from the field of public health in the USA. They suggest that 'not all forms of TDS [transdisciplinary science] involve collaboration – TDS can be pursued in either a *noncollaborative* or *collaborative* fashion'. However, apart from suggesting that 'individual researchers may work by themselves to integrate and apply the perspectives of two or more disciplines', the remainder of their paper focuses exclusively on collaborative transdisciplinary work undertaken at heavily funded research centres. In a subsequent paper, the solo researcher idea was expanded, and several examples were provided of discipline boundary-crossing behaviour which has led to innovations (Fuqua, Stokols, Gress, Phillips, & Harvey, 2004).

On the DBA and DProf programmes I manage, students tend to be selective in their reading of disciplinary literature, an approach that is driven by the problem-solving requirements of their workplace change project. It would be unfair to suggest that they do not consult academic literature of a disciplinary nature, which they do, or that they eschew academic or scientific theories and models, which they do not. However, any academic literature they might consult is meant to support their organisational change project, though they are also required to produce knowledge that will be of interest to other professionals as well as academics.

Enengel, Muhar, Penker, Freyer, Drlik, and Ritter (2012) provide one of the few published studies of the way in which doctoral research students are prepared for their TR work. In order to accommodate the limited time and cognitive resources available to their students, the course they have devised adopts a coping strategy, which involves the stripping down of two key requirements of the students' projects. First, in terms of *cross-disciplinary participation*, researchers are required to consult between two and four disciplinary experts only, which is fewer than many geography graduates would consult when embarking on a PhD research project. And secondly, in terms of *participation with non-academics*, only a low level of participation is required during the problem definition phase, a stance that appears to run contrary to the tenets of most collaborative TR, and this participation only picks up in the closing phase.

It could be argued that this is a pragmatic solution to the twin problems of TR faced by solo researchers. It implies that a transdisciplinary-light version of a solo research project is better than none at all, and can at least serve as an initial training experience. Indeed, if we combine the statement by Nicolescu and others in article 3 of *Charter of Transdisciplinarity* (Nicolescu, Morin, & de Freitas, 1994) that 'transdisciplinarity does not strive for mastery of several disciplines', and Moran's (2002: 16) somewhat informal definition of interdisciplinarity as 'any form of dialogue or interaction between two or more disciplines', then we arrive at a minimalist version of transdisciplinarity which might involve a solo researcher learning just enough about a pair of disciplines to undertake an integrated research project. I am not convinced, however, that this is what these commentators necessarily had in mind.

There is perhaps an alternative way of supporting solo researchers who engage in TR projects: the multi-student doctorate, as this would enable each collaborating researcher to contribute from their own monodisciplinary perspective. However, this would probably require a change of university regulations to make it viable. The vast majority of PhD research projects, in almost every discipline, adopt the solo model, largely because it makes it relatively easy (plagiarism aside) to identify the individual to be credited with the work reported in the thesis. Since effective TR often requires cross-disciplinary collaboration, then team-based PhDs[6] might be a more appropriate vehicle for encouraging such work, across multiple disciplines, and even among several types of participating organisation. The resulting award might need to be validated by several university partners, and individual student team members would need to prepare a thesis that was complementary to other team members. In the absence of specific regulations for multi-student doctorates, they could perhaps be accommodated by conventional doctoral awards, where several students from multiple disciplines, professions, and/or other agencies work on a cross-disciplinary project, but submit independent theses at the end. Clearly, each student team member would have to acquire funding, demonstrate suitable research capability and produce a thesis that reflected individual research contributions, as well as indicating the collaborative nature of the shared research enterprise.

In the relative absence of evaluated examples of lightweight models of transdisciplinary projects for solo practitioner–researchers, and of institutional arrangements that might facilitate multi-student doctorates, I have looked for an approach that supports change-related organisational research projects undertaken by solo practitioner–researchers. I have no quarrel with cross-disciplinary approaches to research. Indeed, I have a career-long affinity with them. However, having thought

[6] These are not the same as the 'Team-based PhDs' offered in some US universities where it is the preparatory learning prior to individual research project work that is team based (e.g. research.duke-nus.edu.sg/nbd/index.php/phd-program.html). Nor are these the same as 'joint PhDs', which are awarded to individual students by more than one university. Nor, finally, are they the same as some of the 'collaborative PhDs' or 'collaborative doctorate awards' funded in the UK (e.g. www.ahrc.ac.uk/funding/opportunities/current/collaborativedoctoralawards/), which are jointly supervised by a university researcher and a recognised member of staff of a non-university organisation, and are similar to the 'Industrial PhD'.

deeply about TR, I conclude that AR is more appropriate for our professional doctorate students, because it works better in meeting the needs of the solo practitioner–researcher working in an organisational context.

There are at least three distinctive features of AR projects, apart from the solo nature of our own students' research activities. The first is that there is a reversal of the usual situation where external academic experts contribute to change within an organisation, because in our case, the student is internal to the organisation, operating as an embedded practitioner–researcher. While their root expertise is largely practice based, they 'import' relevant academic knowledge and expertise from their project tutors and academic advisers, in addition to undertaking focused reading of relevant academic literature. As a consequence, our AR students do not tend to engage in significant levels of participation with researchers outside their own organisation.

A second key feature of AR is that the researcher, as practitioner, is intimately involved in the real-world context of the research project. This contrasts with many team-based TR projects, where the academic doctoral researcher tends to remain outside the lived experience of those who practical problems are being investigated. Parallels can be drawn with participant–observer researchers encountered in anthropological and ethnological research. In our doctoral AR projects, while the student can be considered in some sense as a participant–observer, a key difference is that they are also an insider or embedded researcher, and are therefore already a native of their research environment. In anthropological and ethnological research projects, there is an ever-present danger of the academic 'going native' in their adoptive culture. In an AR context, there is the opposite concern: that the practitioner–researcher, as the embedded 'native', will not immerse themselves sufficiently in the external academic culture and therefore fall short of undertaking a theoretically informed research project. There is, of course, the opposite danger: that our practitioner-researchers might feel the urge to 'go native' in relation to the academic world.[7]

A third distinctive feature of AR projects is that practitioner–researchers do not just prescribe change, as with many management consultant visitations to organisations, and some applied TR project participants, but they actually engage in designing and implementing change from the outset. This means that the practice-based knowledge that they develop not only benefits the evolving business change project, but also leads to subsequent output from the completed project in the form of academically valuable knowledge.

Because the current canonical form of AR is based, as with much TR, on collaboration between multiple individuals and/or teams, we have reconfigured participatory AR to meet the needs of our practitioner–researchers, who are located as solo researchers within the confines of their working environments. While the problems addressed by their projects may not seem to be of immediate societal relevance or

[7] This does happen from time to time, and we have supported a small number of professional doctorate students who have developed an overwhelming urge to explore issues from a largely theoretical perspective to transfer to the more academically focused PhD programme.

benefit, they do have a clear 'problem' focus, and are defined in a way that delivers benefits to their organisations. We encourage and train our practitioner–researchers to adopt the best of what academic research has to offer in terms of clarity of thinking about ontology, epistemology and methodology, as well as axiology. Ethical issues are never far from the surface, and are addressed as an integral part of the individual intervention-based project. A critical self-reflective approach is encouraged throughout all AR projects (Schön, 1984), as well as a degree of reflexivity towards the fundamental value systems of the organisations in which they work (Mezirow, 1998).

The acquisition of relevant academic knowledge and research skills is not always as difficult as it might seem. This is because many of our professional doctorate researchers already have an academic background, and many enter our programme having undertaken a Master's degree involving a research project of some kind, often preceded by a research methods module. The greater challenge usually lies not so much in developing in-depth knowledge of relevant literature across multiple disciplines, but in turning away from the linear model of research with which they are most familiar through a Master's degree project. There is also the challenge of learning to meld academically oriented research with the action elements of their project. Even where our professionals are familiar with a cyclical approach to professional work (e.g. the scrum and sprint concepts in agile software development), they can still experience difficulty in conceptualising an in-house, change-related project in AR terms. It frequently takes students several attempts to map one or more multi-stage AR cycles onto their workplace project.

14.9 Conclusions

Not all readers will agree with the conclusions drawn from the sources used in this study to compare TR and AR. It could also be argued that the dice were loaded in favour of AR in the design of the study, on two grounds. First, the specific nature of the research projects that students are required to undertake on our professional doctorate programmes (their practice base, and their focus on organisational change) have remained the same for this exercise, and it could be argued that these were designed with AR in mind. There is an element of truth in this assertion, because practice-based projects involving change management appear to exhibit a more natural fit with AR rather than with TR. Because of this, a different outcome from the exercise might have emerged if the twin features of the research projects had not been specified beforehand. It should be noted, however, that when the programmes were first designed, the two current requirements were not included in the programme specifications. These emerged over the first 2 years of running the programmes, when it was found that a laissez-faire approach to student selection of a research approach was making it more difficult for projects to exhibit a consistent standard of research quality. It was also proving difficult to find the broad range of academic advisers within the Business School, and it led to difficulties in

positioning the programmes in relation to other professional doctorates, both within and outside the university. For this last reason, the practice focus of the research projects would almost certainly have been adopted even if a TR approach been chosen when first running the doctoral programmes.

A second criticism of this comparative study could be that TR seems to have been made to jump over a higher bar than AR. AR can be seen as is a sitting tenant in our study, and it is often more difficult to remove such a tenant than to move a new tenant into an empty property. If the two research approaches had been in open competition when the DBA and DProf programmes were first designed, TR might have had a better chance of being chosen over AR in a straight fight. While this argument also has some merit, several of the drawbacks identified for TR as a research approach for our students would also apply in professional doctorate programmes offered in other higher education institutions, as well as in academic PhD programmes.

Doctoral research students now have a greater set of options to choose between when deciding on a broad research approach for their doctoral projects. They may confine their choice to the well-recognised trio of cross-disciplinary approaches that are increasingly discussed in the literature (i.e. multidisciplinary, interdisciplinary and transdisciplinary), or they may be more open to the wider range of approaches identified at the start of this chapter. A general conclusion that can be drawn from this exploratory study is that there is no universally 'best' approach to research for most students. A corollary is that alternative research approaches should be prepared to compete on the basis of their fit to specific students' research project requirements. As with faiths and political ideologies, research paradigms need to submit themselves to the marketplace of ideas (Shepherd, 2004) and, where there is a marketplace, informed choices need to be made. It is hoped that the current case study will not only help professional doctorate students to make more informed choices, but it will also assist doctoral programme providers in ensuring that the benefits and disbenefits of the research approaches they champion are more clearly documented and evaluated.

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Part IV
How to Build Bridges: Career Stories That Connect the Humanities and the Sciences

Chapter 15
How to Build Bridges: Career Stories that Connect the Humanities and the Sciences

Kenneth L. Campbell, Arthur Eisenkraft, Margaret Hart, Conevery Bolton Valencius, S. Maria Sonin, and Jungah Kim

Since spring of 2013, we have offered a junior Honors Colloquium through the Honors Program/College at the University of Massachusetts Boston. We recently summarised our experiences with that offering and concluded that the most efficient and effective way to instill the habits and means of inter-, cross- and transdisciplinary thinking in trainees is to provide a forum for students to interview and directly interact with individuals who have incorporated those habits and means in their own careers (Campbell, Kim, & Bruss, 2016). Whether that decision was arrived at early or late in the career trajectory, was not important. The ability to see how others had struggled with and negotiated life and career decisions and arrived at emotionally and psychologically fulfilling positions that allowed expression of both technical and aesthetic parts of people's personalities was a key to students understanding, adopting, and incorporating such attitudes and ideas as they moved beyond our course and ultimately beyond the academy.

The stories told by each of the visitors who participated in our Honors Colloquium were different, personal and powerful. It is our hope to bring a few of these to a wider audience by writing them down. We thank the editors of this volume for the opportunity to publish six of these stories.

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15.1 Kenneth L. Campbell: *How Can I Contribute?*

Mine is a story of evolution, an accumulation of experiences from traditional roots in the physical sciences towards a perspective coloured by contact with literature, travel, other cultures and other academic disciplines.

A Baby Boomer, second of five children in a transitional farm-to-suburban family near St Paul, Minnesota, family finances were slim and the greatest fulfillments came in successes at school. These were general early on, but with the launch of Sputnik and the dawn of the Space Race, *My Weekly Reader ('Man Launches Spacecraft Number One',* 1957*)*, I gravitated toward science. Early fascinations with spring flowers, animals, the sights of the back yard and the farmland next door, gradually aligned with the wonders of growing mineral crystals, making images with radiation sources and borrowed x-ray films, investigating the recently described molecule DNA, creating old and new alloys using explosive reactions and totally inadequate safety precautions that my parents' home and restaurant survived, and probing thermoelectricity. Through high school I worked for tips as a waiter/dishwasher/janitor at the home restaurant. At graduation, I swore I would never work in retail or services; rather, I wanted to contribute and move up in society by doing hard science or engineering, working with things, not people.

In college, along with maths, chemistry and physics, I encountered Greek Classical Literature, Eastern Religions, Art History, Economics, Freud, Fromm and Erickson, Biology and dissections and Cell Biology with histology and microscopes. I worked as a dishwasher, a game room attendant, a dorm counsellor. I learned glass blowing and synthesised gaseous silicon compounds. In summers I tested dishwashing detergents, counselled at a YMCA camp and was a surgical suite janitor. In summer 1969, before senior year, a friend and I drove through the plains and woodlands of North Dakota, Manitoba, Saskatchewan, Alberta and the Northwest Territory, to the shores of Canada's Great Slave Lake just below the Arctic Circle. My world had expanded, I learned the thrills of travel. We got back just in time to watch Neil Armstrong's first steps on the moon. I never managed to schedule the music theory course I wanted. But, nearing graduation, I no longer censured career work with people and considered medicine or environmental science.

Vietnam raged. My low draft number guaranteed military induction unless graduate training involved me in teaching medical students. I also needed a fellowship to pay expenses. University of Hawai'i, Developmental Biology, a paradise but low stipend; University of Wisconsin, Physiological Chemistry, a low stipend; or University of Michigan, Biological Chemistry, a good stipend and the needed teaching involvement? A summer job at the Federal Water Pollution Control Agency in Duluth, Minnesota, engaged me in regulatory work on problems affecting thousands of people. I read Carson's *Silent Spring* (Carson, 1962) and decided to investigate the effects of persistent, chlorinated pesticides on mammals rather than on Carson's birds. In August, 1970 I left home for Michigan with a used car and a foil-lined can my mother gave me of provisions including raw hamburger. *Steak tartare* remains unappreciated.

Graduate training was intense and trips to a girlfriend in Wisconsin, to the Michigan woods, to Minnesota for holidays, or to the shores of Lake Huron provided respite, needed contact with my native natural world. Waking to a meadowlark was common in Minnesota, rare in Michigan. I was far from my beloved fishing lakes, but my research project was unique, it attracted funding from the Environmental Protection Agency and it engaged me deeply in interdisciplinary research, toxicology, endocrinology, analytical chemistry. Unfortunately, or, perhaps fortunately, my insistence on designing my own dissertation project (Campbell, 1977), rather than adopting a part of my mentor's programme, prevented my poor mentor from being of much technical assistance. I made what seemed slow progress but I learned steroid chemistry and took an endocrinology course. It fascinated me because it was relevant and because it integrated so much chemistry, biochemistry, physiology and medicine. Finishing my dissertation, I started a postdoc at the Reproductive Endocrinology Program (REP), University of Michigan.

At REP I studied ovarian physiology, trying to determine how the protein hormone chorionic gonadotropin stimulated the rat ovary to induce egg expulsion; what happened first, what next. I learned protein and steroid immunoassays. During daily noon group seminars I linked my basic work to applied human and animal medicine. Seeking a way to follow hormonal effects on individual ovarian support cells, granulosa cells, I created a procedure to do just that (Campbell, 1979). My work immersed me in electron microscopy, a new set of tools, methods, reveling in what became visible when it normally was not, even with a light microscope. Some images were haunting, some engaging (Fig. 15.1).

Still, it was a basement lab, without sunlight. Breaks for conferences, holidays, or just going home at night were opportunities to see the sky, an indigo bunting, a raccoon family, a frantic marmot that ran into my foot as I bicycled by, or to ski across the winter snow on the golf course near my apartment. Lab science was good, but a search for more relevance to humanity led me to much non-science reading, non-fiction, history, philosophy of science.

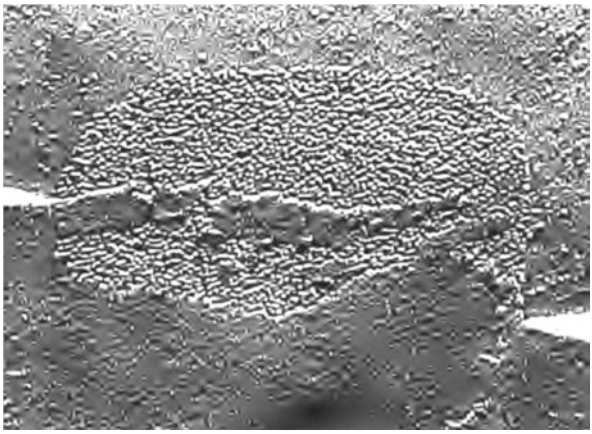

Fig. 15.1 Transmission electron micrograph; rat granulosa cell gap junction, frozen, fractured gold coated; 1978, K.L. Campbell

Searching for career positions, I accepted the first fellowship offered under a grant from the Mellon Foundation given jointly to the REP and the Population Studies Center (PSC), University of Michigan. The PSC included sociologists, economists and demographers interested in population problems. Part of my job was to search for projects and people who could pursue questions using tools and information from both the social and the basic sciences, i.e. initiate transdisciplinary research. To begin, I collaborated with an economics student to compile a joint lexicon and conduct a series of joint PSC/REP seminars to introduce the lexicon and probe for people and projects that might bridge the centres. We identified a new post-doc in Human Genetics, James Wood, who had done a anthropologic reproductive life history of a small, isolated population in Papua New Guinea, the Gainj (Wood, 1980). There were still dregs of serum left from Dr. Wood's study, originally used in genetic examinations. I measured several steroid and protein hormones in those samples. The measurements confirmed most of Dr. Wood's findings but now gave them a new dimension, a physiological, chemical underpinning (Johnson, Wood, Campbell, & Maslar, 1987; Wood, Johnson, & Campbell, 1985a; Wood, Johnson, Lai, Maslar, & Campbell, 1985b). The joint effort was the basis for a subsequent grant from the National Science Foundation for a second field season among the Gainj (Fig. 15.2). I happily joined the field team near the end of that season. It allowed me to see the field conditions, to work with the population, to conceptualise how to improve collection of similar field data and samples. On walks beyond the research huts I experienced and photographed the tropical rainforest, the insects and birds, the interactions of the people with their environment. Waking as the only non-Papuan in a forest hamlet to an orange dawn at the end of a night filled by a sing-sing, ritual dance, involving several nearby groups regaled in feathers, hides, furs and woven fibres, and watching the nearly exhausted dancers wander off as silhouettes against that sky was a riveting and irreplaceable vision. Each dancer,

Fig. 15.2 *Destiny? Middle-aged Gainj woman, 1983*, K.L. Campbell

each culture, has a story, a contribution worth hearing, something to add to our overall understanding. Our work and publications (Campbell, 1989; Campbell & Wood, 1988) proved pivotal for a 5-year renewal of the PSC/REP Mellon Award.

As we developed the 1982–1983 field season grant, I moved to the University of Massachusetts Boston. While still collaborating with Dr. Wood, I was contacted by anthropologists at the University of New York at Binghamton concerning a project among the Turkana people of northwest Kenya on fertility that varied with rainfall. It plunged me into a totally different culture, climate and set of technical obstacles for collecting samples and data. During a brief field stay in summer 1988 I saw African nomads at home; watched a flood bore from rains in mountains far upstream turn the dry wadi in front of our housing into a deep stream within minutes; and identified a spitting cobra skin in our outdoor toilet. Our work confirmed delayed puberty in both men and women (Leslie, Campbell, & Little, 1994), suggested high rates of early pregnancy loss (Leslie, Campbell, Little, & Kigondu, 1996), and demonstrated that transdisciplinary collaborations between basic scientists, demographers and anthropologists generated information that was synergistic across the disciplines. Those efforts helped me organise a 1994 international research conference including demographers, sociologists, endocrinologists, physicians, anthropologists and economists all focused on what has become a transdisciplinary sub-discipline in anthropology, Human Reproductive Ecology (Campbell & Wood, 1994) (Fig. 15.3).

In Boston after PNG and Kenya, I focused on making medical care and diagnostics more accessible to remote people. For two decades I have pursued better means of monitoring physiology, endocrinology and otherwise, in field settings, clinics and individual homes (Campbell & Rockett, 2006). Looking for non-invasive ways to monitor reproductive status, progress in pregnancy and sperm production in male cancer patients, I no longer work only on things but concentrate on biomedical translational applied technology.

But research is only one way to be transdisciplinary. From 2005 to 2008, as Associate Dean of Science and Mathematics, I promoted interdisciplinary projects

Fig. 15.3 *Men's work, Turkana Kenya, 1988*, K.L. Campbell

Fig. 15.4 *Australian audubon: Sea eagles, Kakadu NT, 2011*, K.L. Campbell

in the sciences, a model that continues. As a Professor and Associate Dean, I have often served on personnel and programme reviews in non-science departments. The wealth of ideas, materials and information arising there is no less worthwhile than what is produced in the sciences. Those glimpses continue to fuel my interests in reading and engagement beyond pure science.

On a 2011 sabbatical I absorbed the sights, sounds and culture of Australia. It provided the impetus for photography and journal writing (Fig. 15.4). Australia overwhelms with scope and variety. But, it is scarred by social biases towards Aboriginals visible even to a basic scientist and it continues firmly Anglo-centric immigration policies. It was hard not to feel the need for more openness to different human stories. To respond to the needs of those unlike me. So, at UMB in fall 2011, I mentored an international exchange fellow, Dr. Jungah Kim, Department of English, Manhattan Community College, CUNY. After a year exploring whether the Sciences and the Humanities could bridge C.P. Snow's 1959 (Snow, 1959) cultural gap we offered an Honors Colloquium, *Humanity and Humanness: A Debate between the Liberal Arts and the Sciences*. We engaged a student group from many traditional majors in cross-disciplinary study and got them to understand the importance of trans-disciplinarity in solving human and environmental problems. The second offering, with Dr. Neal Bruss, Department of English, UMB, brought students into contact with visitors of varied background who explored arenas well beyond their strict disciplines. That second offering cemented our conviction that personal contacts and narratives were the most powerful tool in conveying the importance and power of thinking beyond disciplinary boundaries and creating new tools and knowledge to attack new and persisting problems and new works that go beyond what is now available. Experience with the colloquium prompted publication

of the results from the first two colloquia (Campbell, Kim, & Bruss, 2016) and it built a collaborative network among the diverse presenters. We shared some of that with a conference in August 2016 (*11th International Conference on Interdisciplinary Social Sciences*) and hope to stimulate similar efforts elsewhere. My path has led here, to work that has changed the minds and opened the eyes of both student and instructor colloquium participants. I now know these offerings can train a generation of transdisciplinary thinkers and problem solvers.

15.2 Arthur Eisenkraft: *The Art of Teaching Physics*

I was recently asked to comment on policy makers who advocate teaching science, technology, engineering and maths (STEM subjects) to the exclusion of French literature. My first response was that I like plays and music and poetry and art. I later stated that my science instruction would be compromised if the arts were not a part of my lessons. The arts are a cross-disciplinary tool for engaging students as well as providing additional models to explore science concepts.

Art, literature and poetry provide the bridge between the need of the student to provide input to class discussions and my need to insure that students learn physics. I've succeeded in finding multiple ways to construct these bridges. Sharing these reveals both my interest in physics and the arts. While the students are reading *Grapes of Wrath* in literature (Steinbeck, 2000), I asked them how Steinbeck views science and technology. When Steinbeck describes the tractors raping the earth, why does he choose that metaphor? What metaphor might someone who admires this technology use? How do we view technology in science? Where do we use technology in science? Similarly, when Paul Simon sings about the 'Boy in the Bubble and the baby with the baboon heart,' how does he view technology? 'The way we look to a distant constellation that's dying in the corner of the sky… These are the days of miracle and wonder… And don't cry baby don't cry' (Simon, 2004). What are the positive and negative consequences of technology in society?

There is a poem entitled *Thermometer Wine* by Robert Morgan (1983). When studying thermodynamics, we read the short poem in class and I asked students what was meant by the lines, 'Only Daddy could tell the measurements – he'd known the instruments since a boy. At ten below it was roughly accurate, but on a hot day he added twenty to its reading.' Being literal, some students immediately conclude that the thermometer is inaccurate. Other students had further insights and interpretations. One student volunteered, 'Distrust of science. Thermometers and other instruments don't tell us the truth.' A second student contributed, 'The father is saying that the son needs him to help him to interpret the world.' While a third student remarked, 'The father remembers that everything is more extreme when you are young and therefore tells the son to add twenty because that's the way it would feel to him.' It was only a few minutes of class time but the poetry interpretation added to our thoughts about heat and temperature. The students were now vital contributors to the classroom and I, as the instructor, was learning from them.

Using tape recordings of notable scientists, the American Institute of Physics compiled an audiotape history of the discovery of nuclear fission (https://www.aip.org/history/exhibits/mod/; Physics, 2016). Accompanying this audiotape history was a teacher guide that we developed. In that guide, we encouraged teachers to recognise that science, technology and society are all present and not to limit discussions to the physics of nuclear fission. Nuclear fission research took place in a world that was about to go to war. One exercise focused on one aspect of this:

> George Gamow, a noted physicist, said that 'the fission of the uranium nucleus can be considered a very interesting paragraph (but only a paragraph) in the story of physics.' Fission has taken on an importance beyond this because of the technological applications which are derived from its discovery. How has the discovery of fission and its byproducts, nuclear power and the atomic bomb, influenced the way our society views science?

Another exercise asks students to consider the role of fate in history:

> Enrico Fermi and Emilio Segrè did not discover uranium fission, although fission did indeed occur during their 1934 experiments. Segrè is quoted as saying, 'The whole story of our failure is a mystery to me. I keep thinking of a passage from Dante: "O crucified Jove, do you turn your just eyes away from us or is there here prepared a purpose secret and beyond our comprehension?"' What is Segrè implying by this quote? How might world history have been altered if the discovery of fission occurred before the emigration of physicists to the U.S. and well before the start of World War II? What does this suggest about the role of chance in history?

A major effort in combining art, literature and physics culminated in the publication of *Quantoons* (Bunk, Eisenkraft, & Kirkpatrick, 2006). My colleague Larry Kirkpatrick and I began writing a column for a magazine that was to be a collaboration of the USA and Russia. We created contest problems for each issue. The physics was great, as were the literary quotes accompanying each, but better illustrations were needed. Tomas Bunk, a professional cartoonist with credits including *Mad* magazine and *Garbage Pail Kids*, was approached. His first reaction was that he did not know physics. I responded that this might be why we needed him. I then asked him how he might illustrate our next column which concerned light. Tomas responded, 'I guess I would draw light like a superhero because it travels so fast' (Fig. 15.5). And so the collaboration began. Of course, as Tomas learned enough physics to illustrate that first picture, I learned about art. The cartoon became another dimension to the Contest Problem. As the Contest Problems evolved, so did Tomas' illustrations. They began to take on political commentary, historical ideas and larger issues of philosophy while always providing insights into the physics with whimsy and humor.

Quantoons adds a feature that was not present in the original *Quantum* series. Each illustration now has a brief commentary by Tomas Bunk. This peek at the creative mind of a visual artist not only provides insight into how Tomas views the world, but also how people who are not trained in physics can appreciate the world of science and make it their own.

A physics problem having to do with a split lens (one which is broken into two parts) led Tomas to make a political statement through his art (Fig. 15.6).

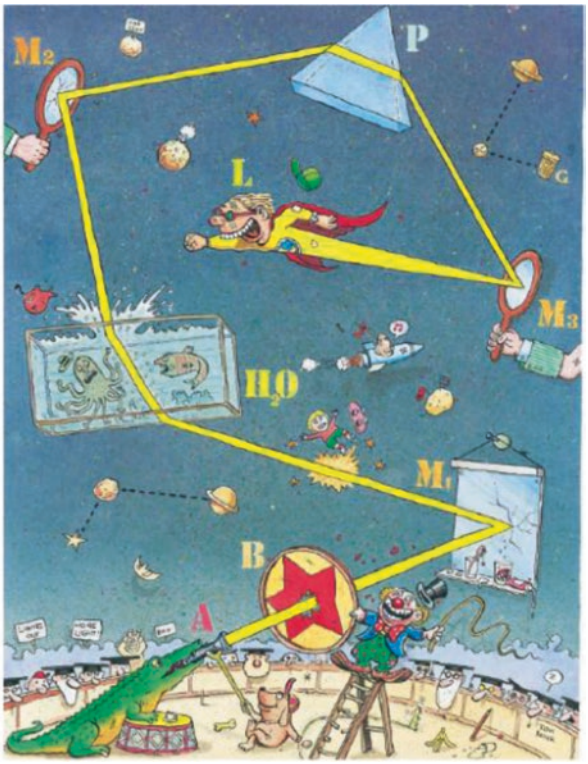

Fig. 15.5 Light is bending the rules a bit here. (Can you see where?) (© 2006 National Science Teachers Association (NSTA). Used by permission)

In a physics problem having to do with springs and oscillations, Tomas built on the Camus quote accompanying the article to make a statement regarding history.

> The world is never quiet, even its silence eternally resounds with the same notes, in vibrations which escape our ears. (Albert Camus) (Fig. 15.7)

All of the examples given above are ways to motivate students. They provide new insights into physics content and more importantly provide a vehicle for students to contribute their thoughts and their creativity to the class. Many of these examples require the students to respond to a prompt. They do not take too much time away from the physics content.

We can extend these examples to situations where students have a more active role. Students can create their own 'quantoons'. Students can write their own poetry or compose their own songs.

Better yet, the integration of science and the arts can create not merely a bridge but a new landscape for instruction. In project-based learning, students are given a problem that they must solve. That problem becomes the reason why they are learning the science content. Two large curriculum projects I led have set the standard for project-based learning. In *Active Physics,* students have one month to create a light and sound show to entertain their friends. To do this, they must learn the physics of

a

After reading the title of this article, I decided immediately to use it for my illustration. Split is where I was born and where I grew up, a beautiful city on the Mediterranean coast of Croatia. Looking back on my childhood, Split meant always the most perfect place—the temperate climate, the azure blue sea, the town rich in history, founded by the Romans. But in 1995, when I drew this illustration, bloody war was raging, which shattered my image of a perfect paradise. The illustration shows the sunny past, but under the fractured lens we see the sinister side, the destruction and death. Today, ten years later, the fragments of the broken lens have grown together into one piece and the light that passes through is pure and perfect again.

—T.B.

b

Fig. 15.6 *Split is a beautiful old town on the Adriatic Coast in Croatia, where the artist was born* (© 2006 National Science Teachers Association (NSTA). Used by permission)

string and woodwind instruments. In *Active Chemistry,* students have to create an art object to hang in a museum. They must also create the placard that will be next to their art that will describe the chemistry principles that were necessary to create their art. In both of these examples, the arts are front and centre. The chapter challenges can help students learn science but the arts are a reason why they are learning this content.

I am reminded of the congressional testimony of Robert Wilson, the physicist responsible for securing funding for Fermilab. When asked by Senator Pastore, 'Is there anything connected in the hopes of this accelerator that in any way involves the security of the country?' Dr. Wilson responds, 'It has nothing to do directly with defending our country except to make it worth defending.'

Science and the arts belong in all classrooms.

a

Within the frame of this broken mirror we find ourselves in the Germany of the late 1930s. A voluminous singer of Wagnerian proportions is blasting her high-pitched voice into her surroundings, creating vibrations that cause crystal goblets to shatter. In this case the image hints at the so-called *Kristallnacht*, when Jews were beaten and killed by organized thugs all over Germany. Shortly after this incident, Hitler's *Autobahn* was convulsed by marching boots rumbling through the earth leading straight into the hell of World War II, the destruction of cities and millions of lives. Some, like Einstein, managed to escape in time to reach the boat to safety. The innocent little girl is swinging happily to new heights, creating good vibrations, but they could not compete with the poisonous ones that ruled the times.

—T.B.

b

Fig. 15.7 *Tomas Bunk connects springs and oscillations to history* (© 2006 National Science Teachers Association (NSTA). Used by permission)

15.3 Margaret Hart: *Domestic Technologies and the Intimacies of Telephony*

My most recent creative project started with a collection of voicemails saved on a cell phone. These voicemails preserved the last messages left by my deceased mother. Captured on a Razor flip phone, they were trapped there when I decided to upgrade my service. At the time, the technology to transfer them did not exist. As I dealt with the loss of my mother, I held on to that outdated cell phone as a sort of talisman. It housed an emotional catalogue of voicemails and, as long as I had the phone, I could play back the messages (Fig. 15.8).

Fig. 15.8 Margaret Hart, *Intimacies of Telephony, 2015* (Artist owned)

Fig. 15.9 Margaret Hart, *Intimacies of Telephony, 2015* (Artist owned)

These voicemails were the beginning of a large-scale installation titled 'Intimacies of Telephony', wherein I canned over 200 telephones to preserve, collect and catalogue the information held within (Hart, 2015). This work was also greatly influenced by my research into the history of telephone technologies and feminist communication theory. Although my installation begins from a place of personal narrative and preservation, it ultimately addresses more universal concepts of domesticity, gender politics and issues of communication (Fig. 15.9).

15.3.1 Inquiry

There may be no greater technological invention impacting women and domestic life than the telephone. This tool contributes to the social construction of women's identities as well as their engagement with space, both public and private.

The advent of wireless technology and social media has encouraged some feminist scholars to study how specific constituencies have assimilated these technologies. This paper looks at telephony not through segments of women using the technology but at the most common of sites where it is used: the home. It is also from this place that my artwork stems.

Telephone technology entered the home as early as 1884, but it was not until the late 1940s that it became common across many differing social and economic groups. The telephone permitted women to nurture relationships farther afield from the home, allowed increased frequency of contact and gave a measure of agency to women in their dealings with the world at large. As the telephone became a basic home utility, it became gendered: while men used the telephone in their workspaces as a tool to speed transactions, women embraced the telephone in the home as part of their domestic identity.

I will argue that women historically cultivated a sense of community with common beliefs and close personal connections thanks to the telephone's ability to extend their reach beyond the home. Telephony enhanced and expanded women's social networks, which impacted their sense of selfhood and altered their social and cultural practices. A critical examination of telephony and gender is part of the conceptual underpinning of 'Intimacies of Telephony.'

Finally, I will examine how domestic communication technology has connected with feminist critiques concerning domesticity and identity. Through the framework of these issues and lived experience, I begin the conversation with my own artwork and make sense of my own story. Beyond the impulse to can my cell phone to preserve my mother's voice, I ultimately have a need to examine my own identity and gendered perspective and to understand this in the context of feminist art practice.

15.3.2 Telephony

In July of 1877, the Bell Telephone Company was founded in Boston, Massachusetts. Almost from the start, the position of switchboard operator was gendered female, alongside other careers prioritising relationship care. Many histories of communications attribute this gendering to the stereotyping of women as polite, nurturing and gentle. The collages in my catalogue depict numerous images of early switchboard operators, referred to in one advertisement as 'weavers of speech,' who were idealised versions of femininity. The physically multi-layered collages suggest the same layering of memory throughout my work. The stories of the telephones, the reenacted voicemails and the nostalgia of the presentation construct an idealised, albeit nuanced and fragmented version of my relationship with my mother and others.

The telephone's ability to allow women to reach outside the home and build a social network of like-minded women was critical to pre-feminist culture. The telephone worked within society's strictures, connecting one domesticated woman with another. This engagement with others extended an isolated woman's social persona,

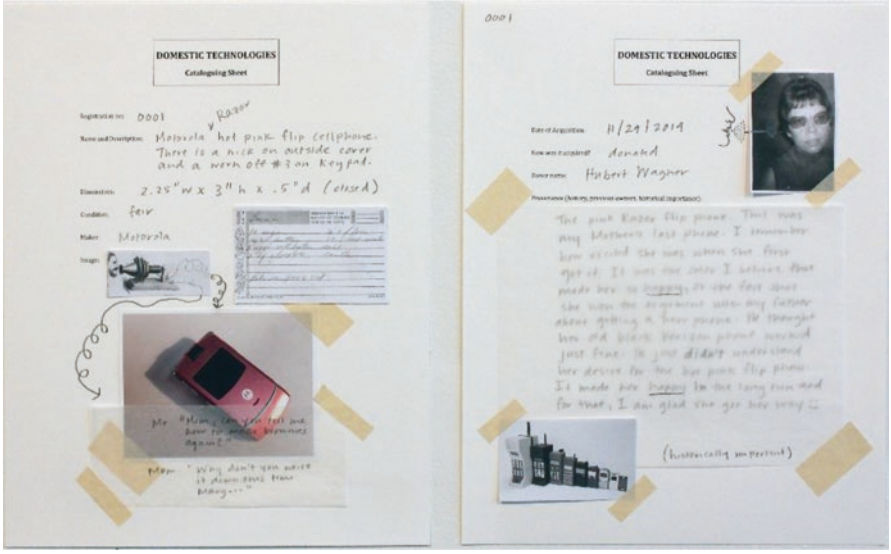

Fig. 15.10 Margaret Hart, *Catalogue of Domestic Technologies, 2015* (Artist owned)

ultimately leading to an enhanced awareness of self as a person empowered with social agency.

In my installation, 'Intimacies of Telephony', I gathered donated telephones and catalogued them (Fig. 15.10). The catalogue is a version of one traditional museum's use, but includes collage and personal narrative elements as well. Each canned telephone has a story. Within these layered images and texts one sees how women, through use of earlier landline phones and mobile technologies, constructed their identities, shared their stories and connected beyond the home with the world in transformative ways.

15.3.3 Home

My artwork engages the notion of public and private in several ways. Literally, the private narratives within the catalogue and voicemails are made public through the display of this work, while the trapped recordings and images on the smart phones are still very much private. Even the earlier wired phones suggest past conversations preserved, but stashed away out of public view.

Hilde Heynen exposes the contradictions found within modernity regarding architectural practices and gender. In her article 'Modernity and Domesticity: Tensions and Contradictions', she asserts that as the home came to be solely a space of residence, cultural assumptions about the different 'natures' of the genders

emerged (Heynen, 2005). The role of the female was inscribed with childcare, food preparation and housework, thereby defining domesticity as feminine, while masculinity was aligned with the qualities of reason, the pursuit of progress through activity and public life.

Architecture thus evolved to suit new norms and serve as setting to emerging ideas of identity. Building this line of argument, Witold Rybczynski writes,

> [T]he emergence of something new in the human consciousness: the appearance of the internal world of the individual, of the self, and of the family. The significance of the evolution of domestic comfort can only be appreciated in this context…[I]t begins in the appreciation of the house as a setting for an emerging interior life. (Rybczynski, 1987)

This new interior life had different implications for men and women, solidifying gender roles within the home. Men exited the home for work; women remained behind to care for children and create the comforts so required of residential spaces.

By canning the collected telephones, I am alluding to domestic and gendered spaces. Having been raised in the Midwest in a middle-income family, many of these domestic stereotypes exist within my own history. Gardening, cooking and canning food were tasks completed with my mother while my father was at work. Even though my mother also worked, as a child, I never questioned this division of labour.

In my own life, the telephone played a huge role in navigating my relationship with my mother. When leaving home for college, landlines and answering machines allowed us to continue our daily conversations. The advent of mobile telephone technologies expanded the scope of our connections, as I took her with me when away from my residence, the home I had constructed for myself. Rather than change the daily narrative we had established with older telephone technologies, it sustained us.

Since much of my artwork stems from personal narrative, it was only natural that I deal with the loss of my mother there. For me, the canned telephones embodied all the conversations I had had with my deceased mother, the saved voicemails, the images (in the case of smart phones) and the potential for those moments to be preserved in time. They hold the metaphorical possibility to be opened and heard (or viewed) again. This speaks to the human impulse to maintain memories and experiences that may otherwise vanish.

15.3.4 Self

I got my first cell phone in 1997. I was a young college teacher in upstate New York and knew very few people. Having access to a phone whenever and wherever I was made the transition to my new life easier in many ways. I could call family and friends when feeling lonely and I could easily record contact information of the new people I met.

Fig. 15.11 Margaret Hart, *Mapping Memory2 (as part of Intimacies of Telephony), 2015* (Artist owned)

Historically, telephone technology has facilitated connection with various communities, encouraged economic advancement through home businesses and extended agency in social arenas. Teresa de Lauretis writes about this as a 'technology of gender.' Lauretis proposes that technologies of gender concern themselves 'not only with how the representation of gender is constructed by the given technology, but also how it becomes absorbed subjectively by each individual whom that technology addresses' (Lauretis, 2004). She posits that women are not passive recipients of technology. They are active agents who use technology to construct their own subjectivity and self-representations.

Carla Ganito expresses this well in her article, 'Women on the Move: The Mobile Phone as a Gender Technology'. She writes, 'Through the mobile phone, women are building up more intimate relationships with technology, learning to accept new media and are becoming producers' (Ganito, 2010). As an artist, I am participating in this cultural production and further developing my understanding of and contributions to the dialogues surrounding identity, domesticity and gender politics.

In earlier artworks I began dealing directly with gender politics and technology. This exploration would continue in many future pieces, ultimately finding its way into 'Intimacies of Telephony' (Fig. 15.11). Beyond the obvious reference to technology through the use of telephones, this installation includes a short video. I mounted an iPhone 6 directly to the wall to display the video; a looping collage of family photographs, medical diagrams and found film footage. Layered voicemails from mothers to daughters weave in and out of auditory reception in the background. The video itself becomes a memory through a cacophony of visual and auditory montage techniques.

15.3.5 Future

The extensions of mind and body, technology and culture offer great potential for creative endeavours into questions of identity as Donna Haraway does in her pivotal essay, 'A Cyborg manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century', where she uses the image of the cyborg to challenge culturally engrained dualisms (Haraway, 1991). Cyborg metaphors, according to Haraway, lead to new understandings of identity politics. In this post-gender era, she asserts, identities are in constant flux and new strategies are required to represent this postmodern political landscape.

We already are cyborgs, argues Andy Clark in his book, *Natural-Born Cyborgs: Minds, Technologies and the Future of the Human Race*. We *require* tools in order to grow and develop. Clark states,

> ... the old puzzle, the mind-body problem, really involves a hidden third party. It is the mind-body-scaffolding problem. It is the problem of understanding how human thought and reason is born out of looping interactions between material brains, material bodies, and complex cultural and technological scaffolding. (Clark, 2003)

Our need for tools inherently makes us cyborgs, he argues, no implant or prosthesis needed. Exhibit number one is the cellphone, a technological augmenting of self (Clark, 2003). As women embrace communications technology (their cyborg-selves?), instead of fashioning cold steel and alienation, they build more intimate relationships and become producers of culture.

Clark's 'mind-body-scaffolding' problem offers means for thinking about how we, in particularly women, use technologies as constructions and extensions of the self. Through disciplined study of this dense and layered arena I will continue to produce relevant artworks, which contribute to the larger social and cultural dialogue. Through the telephone and other communication technologies, female identity continues to evolve. Perhaps it is more accurate to say, as Haraway suggests, many female identities evolve and these identities are no longer firmly tied to the domestic space. With current and future communications technologies, women are constructing and re-constructing their own subjectivity; having more tools than ever to effect change in their own social and cultural narratives.

15.4 Conevery Bolton Valencius: *Following Questions Through History and the Sciences*

I'm a teacher and writer in environmental history and the history of science and medicine. Some of the most fun I have in my work is when science majors in my classes learn the history of the fields they've learned about more technically – when I have pre-meds, for instance, learning about the historical roots of 'germ theory' or the context for the development of lab protocols. In my research, I relish learning how people in other fields understand the same subject from another point of view.

As a historian, a piece of hydraulic fracturing technology looks like a stunning and complex technological achievement based in many decades of mechanical innovation, business practice and resource extraction. To an engineer, it might be a useful tool constantly in need of tinkering and refinement. To an anti-fracking activist, it might look a travesty. For me, trying to understand my students' surprise and my colleagues' different perspectives means listening for the different questions we ask, and following those questions into the past and sometimes in the present.

My first book came out of reading documents and being puzzled by them. I began to study the nineteenth-century history of Western emigration across the Mississippi as an undergraduate when my dad, a historian, hired me to do some research and I was shocked at how little had been written based on primary sources from the small rural state of Arkansas. I figured that gave me an opportunity, so I wrote an honours thesis about the meaning of health and illness in family correspondence in Americans moving into Arkansas. I then set out to figure out what to do with myself as a college graduate. After working a while, I paid my rent one month with the money I earned from an award in women's history from a chapter of that honours thesis (this became my first academic publication (Bolton, 1991)). I realised how much I loved the detective work of being a historian and decided to go to school to do more of it.

As a graduate student I read correspondence about health and illness in historical collections from people moving West in the nineteenth century. I'd find myself looking up from yellowed letters of people moving into present-day Arkansas and Missouri and wondering why they kept writing observations such as 'This is a healthy country' or 'I think this valley will be too sickly.' These were not idiosyncratic or unusual observations, but a constant refrain. Why, I asked, did these newcomers to the Far West constantly ask after the 'health' or 'sickliness' of the land they sought to survey and settle?

By that point, I'd read a lot of books in nineteenth-century American history, and nobody else seemed to notice or ask about this very common way of describing new terrain. I wondered what that all meant. So: I wrote a book to figure it out.

In *The Health of the Country: How American Settlers Understood Themselves and Their Land* (Valencius, 2002), I asked how people thought that land itself could possess 'healthiness' or be 'sickly.' I wanted to understand how people of not that long ago could see the surrounding environment in such different terms than we do now. To figure that out, I became interested in the forms of knowledge that shaped people's ways of understanding the world. I read nineteenth-century health manuals and books about the history of science, but I also read nineteenth-century fiction and learned bits and pieces about folk song, about slave narratives, about the uses of story-telling, and about the power of oral traditions.

The Health of the Country provided a new interpretation of American western settlement as marked at once by bold territorial ambition and profound bodily vulnerability. I presented evidence that early American emigrants understood the environments around them in the same ways they understood their own bodies, using fundamentally parallel processes to manage and heal both land and self. The free, white people who wrote most of the words I read were determined to take and to

'settle' land, much the same way they 'settled down' a disturbed body. Yet they also saw their own selves as being changed by new places, and they expressed a great deal of concern about how their race would be affected by hot Southern sun. Settlers sought 'healthy' highlands, but recognised that the most fertile land for slave-based agriculture was often the bottomlands that threatened the health of enslaved and free people alike. The book helped create lively, ongoing conversations about historical connections between health and environment, especially the way that ideas about race in the United States have been shaped by beliefs about the fitted-ness of certain bodies for certain places.

This question of how people understand the world around them is the central question also of my second book. *The Lost History of the New Madrid Earthquakes* (Valencius, 2013) asks how we know what we know – or what we *think* we know – about the New Madrid earthquakes of 1811 and 1812, great quakes that struck the Mississippi Valley and were felt out to Quebec and Boston. What changes in our understanding of American history and the history of science when we reconsider earthquakes that have been forgotten for almost 200 years? The answer is, in part, a much more complex view of scientific, religious and political struggles in the early nineteenth century.

The New Madrid earthquakes of 1811 and 1812 (named for the small Mississippi River port near their epicenters and pronounced, with regional defiance, 'new MAD-rid') were the impetus for widespread conversation about causation in natural history that I term 'vernacular science,' a set of discussions neglected in our historical analysis because they took place in everyday newspapers, family letters and ordinary commercial journals.

For many Native societies, the New Madrid earthquakes were galvanising: pioneering Cherokee-led communities in the New Madrid hinterland were destabilised and dispersed by the quakes. Across eastern North America, the tremors were taken as a sign by many eastern Indians to heed the preaching and recruitment of Shawnee brothers, Tecumseh and The Prophet, and to unite against the American takeover of land and culture.

The New Madrid earthquakes likewise stirred early American spirituality, showing the bodily nature of spiritual yearning. Both seismic tremors and the Holy Spirit coursed through early Americans like a rush of electricity, and both formed part of an intense spiritual movement contemporaries called 'the Great Revival' (historians usually call it 'the Second Great Awakening'). Recognising the presence and power of earthquakes thus reveals new and neglected aspects of early American history.

At the same time, *The Lost History* is not simply a history of what earthquakes did, but of how they came to be forgotten. It is a case study in the history of evidence and causation. This book asks why events that were self-evidently important in the 1810s could be cast as tall tales by the late nineteenth century, ridiculed as part of quaint Americana rather than serious scientific narrative. How does what was once true become dismissed as environmental exaggeration? This book traces answers by following the original accounts of the New Madrid earthquakes through time, outlining the changing status of breathless narratives of huge spouting sand blows and destroyed forests as they came into and out of scientific credibility. Multiple forces –

scientific, environmental, social, even the military consequences of the Civil War – intertwined to submerge knowledge of the quakes and erode the credibility of these original accounts.

Yet such forgetting is only a mid-point of this story. The New Madrid quakes are a prime instance of 'intraplate seismicity' in a continental interior, quakes far from a plate boundary that do not follow the model of plate tectonic seismicity that explains most earthquakes across the globe. Researchers have very recently become interested in what these tremors can reveal about seismic disruption in mid-continent zones generally. Seismologists now pore over narratives that their older colleagues once dismissed as mere hysteria. Understanding old earthquakes helps us see more clearly not only our past, but our unfolding present.

This earthquake research has led to my current work. I found that the New Madrid earthquakes proved a useful tool for those organising resistance to hydraulic fracturing, or fracking, in regions once affected by the New Madrid tremors. Recent changes in technology have made the mining practice of fracking both possible and potentially economically rewarding on a large scale. These changes are also changing how contemporary Americans understand their geologic and seismic history. In parts of the central U.S., earthquakes apparently related to the waste-disposal processes involved in fracking have dovetailed with increased awareness of the historic New Madrid tremors.

Interest in so-called induced earthquakes – and fear for human-caused tremors – is increasingly part of opposition to fracking in many parts of the United States. Knowledge of past massive earthquakes and reality of present small tremors is creating a new and surprising awareness of the central United States as an area of seismic history and possible seismic future.

I'm asking how we know about earthquakes induced by human action: How does this seismicity occur? What tools help us understand what causes earthquakes? How will the identification of induced seismicity affect our harvesting of energy resources? Essentially the same questions about how people create knowledge and ask questions can lead me from farmer's fields into activists' websites, exploring new material by following the questions I find in the sources in front of me.

In all of my work, I learn from presentations and shared teaching with science colleagues and from conversations with my students. I try to read the writings of people in the past through their eyes, not my modern ones, to understand their actions or decisions in their own terms. Often our contemporary sciences help me see some of the enduring truths of the physical environment and the human form that shape our shared experiences, past and present – and can also reflect our tremendously different historical experiences. Through all my projects, I explore how questions of knowledge shape the literal, physical work human beings do in the places all around them. As I do, I hope to continue to learn from my students and my colleagues as they ask their own questions in fields that differ from my own but can often show me new perspectives on the questions that animate my teaching, my writing, and my thinking about the past and about our present.

15.5 Solveig Maria Sonin: *Turning Points*

As the plane begins its rolling descent, all I can see for miles and miles are palm trees and a thick layer of heat pushing against the ground like a steamroller readying the earth for paving. My first thought, sitting alone on that jumbo jet after a 12-h flight bisecting the globe, was 'I'm not in Kansas anymore.' How did I, a white, middle class, teenager born and raised in America, find herself staring out a tiny airplane window at the alien landscape of the West African capitol of Abidjan? And how would this decision to give up everything I knew for a new beginning as an expat in Africa impact my life and my future career? Little did I know that the fateful decision to pack my bags and follow my aid worker mother so many years ago would lead to a career working with companies in the fight against corruption and corporate misconduct.

I was always a curious child, spending most of my childhood with almost unlimited area to roam and explore – from the deciduous forests of Harvard, Massachusetts to the dry grasslands of Northern California – and I spent many a happy hour dredging through the New England swamps in search of the elusive Four-toed salamander – to later overturning rocks and tentatively examining the curved tail of the Californian common scorpion. I was so fascinated by the natural world that I began an impressive entomology collection and begged my step mother to allow me to dissect a foetal pig – in my spare time. I don't remember when I decided that I was going to be a medical doctor, it was always there like a memory from childhood that you can't quite place but can never forget. I excelled in the typical science and maths curriculum but my introduction to the multidisciplinary truth of learning came early. Being home schooled from a young age, the boundary between the classroom and the natural world was blurred, if it ever existed at all. After reading about ecosystems in a school book, I would clean out the terrarium and set up a community of millipedes, learning through trial and error – at great expense to millipede life and happiness – the perfect balance of community members to ecosystem size. A simple question at the dinner table, such as why the outside of the water pitcher was so wet when the liquid was clearly contained within, would lead to experiments in how the temperature difference of the water and the room affected the amount of condensation. Science was never an abstract – it was life itself. Music became science by examining how the classical composers we listened to after dinner put sounds together in a way that could uplift your spirit or fill you with dread. And it wasn't limited to science alone. History intersected with psychology as we studied the great migrations throughout time and what internal and external factors could push a person to risk everything for a new life. The seeds of transdisciplinary thinking were nurtured from a young age.

Which brings me back to Abidjan and my 14 year old self. Still enthralled with science I now found a new environment to explore, one unlike anything I had ever experienced. From the torrential rainstorms that lasted a mere 30 minutes and the subsequent riot of colours and smells as the flowers awakened to the dry Harmattan sandstorms from the north slowly browning out the sun and laying their calling card

behind in the thick layer of dirt covering every surface. The animals were bigger and wilder and their interactions with humans often comical. I remember sitting at an outdoor café and being pelted with fruit by the monkey in the tree above who clearly found my presence untenable. But the scientist in me found a novel study, something seemingly incomprehensible through my lens of simple science: the humanity of my adopted country. People who had nothing – some days not even sufficient sustenance to survive – survived and flourished, noisily negotiating a chance to get ahead. My years spent in Africa gave me a first-hand glimpse into the limits of economic and political theories. Perfect solutions on paper crumbled in the face of harsh realities. Well-meaning aid workers spent unlimited resources on disease prevention and improvements in public health and while we would see improvement in pockets, lasting and systemic change always seemed just over the horizon. I developed a deep appreciation for the passion and fortitude of all involved in these endeavours but in the back of my mind I wondered why it wasn't enough. Why was infant mortality still 40 children per 1000 and why was AIDS spreading at such an alarming rate, with 75% of prostitutes in Uganda afflicted with, what was then, a certain death sentence.

And then the moment came. The incident that, in hindsight, would be a turning point in my life. We were in a car on a beautiful Ivorian day. The sun was shining and the radio was turned up. If I recall correctly Michael Jackson was the soundtrack of that day. We approached a police checkpoint, a commonplace occurrence that I had encountered numerous times before. But that day, when the police asked for our identity cards, my heart sank. In my rush to leave the house, I had not forgotten my sunscreen or swimsuit but I had left behind the one thing I was told to never forget: my ID card. I wasn't the driver or even the front seat passenger, so I figured my oversight would be overlooked, but it was not to be. As the police officer approached, hand on his weapon, I realised I had made a big mistake. My friends tried to explain the oversight but the officer wasn't keen to hear our excuses. My friends then did what came naturally in that part of the world: they offered the police officer a bribe: 5000 CFA to overlook my impertinence. Every other time this had proven successful, but today – perhaps because the officer's payment for his child's school had fallen behind or maybe his superior was watching and would expect a cut – it didn't. My friends tried to sweeten the deal with the bag of sandwiches that we had recently purchased as a treat after a day of sun and sand, but the officer wasn't having it. He ended up detaining me, putting me in his car and taking me to central booking. This is not an enjoyable experience for anyone under any circumstance, but I was 14 year's old, female, with limited proficiency in French and in a country where due process depended on the whims of those who held the authority position on a particular day. Needless to say, I was more frightened than I had ever been in my life. A few hours and calls later I was returned home to face my mother's wrath, but that is a story for another day. Still, I distinctly remember, as I was sitting in the precinct watching the monetary exchange between the embassy official and the police captain, my only thought was 'how much more did the bribe need to be?'

I left Abidjan and returned to the States to pursue my education, still hell-bent on pursuing my dream of becoming a medical doctor. But then came the arrival of

another precipitous moment in my life. To make ends meet I had taken a string of temporary positions while studying for my medical school entrance exams. A position was open at a non-profit called the Ethics & Compliance Officer Association to help them organise their online library, a few weeks of work at normal temporary pay. The catch was that the commute was over 45 minutes. But my looming rent check led me to jump at the opportunity. One week into the assignment I was asked to help run a one week course in business ethics, *Managing Ethics in Organizations* (MEO), at Bentley University. As I sat in the back of the room, mostly checked out but ready to make copies or assist in getting the projector working, my ears pricked up. One of the presenters began describing the *Foreign Corrupt Practices Act* (FCPA) and that it was actually illegal to pay a bribe. That it was possible for people and companies to conduct business without making 'facilitation' payments. And how, when companies condone or even encourage bribery it leads to a widespread culture of corruption that negatively impacts everyone involved. At that moment it all clicked. Why all the efforts of my mother, and the countless numbers trying to help fight the sickness and poverty that I had seen every day in Africa seemed so futile. And why my own experience being arrested for *not* paying a bribe seemed so wrong. According to the United Nations, 30% of all aid that goes to Africa is lost to corruption. While it can be easy to dismiss figures on a page – even a figure that shocking – it is much harder to dismiss when you have seen the unwilling victims up close and realise that they are innocent pawns in the game that is power and graft. I knew at that moment I had found my calling and that I would do anything in my power to make a difference.

So a decade later what have I learned? And how does this connect to transdisciplinary study? I've spent the better part of my new-found career championing the importance of integrating into business – which is often seen as a distinct, untouchable field – the pertinent and prolific research into human behaviour and social justice. One of the greatest travesties of modern capitalism is that we are encouraged to see the role of the economic sector as merely a series of quarterly returns and profit margins at the expense of humanity. My hope is that approaching business with a transdisciplinary lens will allow us to create better systems that will lift all people, not only the 1% fortunate enough to know how to play the game. By integrating concepts from psychology, such as why employee incentive systems (*Marc Hodak* (EthicalSystems.org, 2016a)) and ethical blind spots (*Ann Tenbrunsel* (EthicalSystems.org, 2016b)) cause people to behave unethically in ways they would never imagine, or concepts from science, with its absolute understanding of cause and effect (e.g. short-term vision leads to increased risk taking), we can create a more sustainable business model that benefits all of society.

I've also learned, on a very personal level, that all of your experiences and all the disciplines you study guide your path in life. If I had not developed at such a young age the mind of a scientist, primed to solve problems and connect elusive dots, or had I not been exposed to the sociological experiment that living in a foreign country provides would I have been open to the career I ended up embarking on? Perhaps I would have become a wonderful doctor, saving lives or conducting groundbreaking research in a lab. But my life took the path it did because I was primed to

see the world from so many angles and not compartmentalise disciplines such as economics, science, psychology, or sociology. I was able to see how they intersected and how each could inform the other to create innovative solutions to very deep-rooted societal problems. I truly believe that it is only by looking beyond our sometimes archaic views of how disciplines can and should overlap that we will create a better, more just world. And I am honoured to be part of that journey.

> Two roads diverged in a wood, and I –
> I took the one less traveled by,
> And that has made all the difference.
> (Robert Frost, 1920)

15.6 Jungah Kim: *The Sound of Silence*

> *Whether we are poets or scientists, we are all metaphysicians, creators of myths.*
> (Michel Camus, 'The Hidden Hand between Poetry and Science', 2008)

One Friday morning in October of 2011, when I was serving as an international visiting scholar at the University of Massachusetts Boston, I found myself sitting in a day-long symposium entitled *Advancing the Life Sciences and Uniting Universities, Corporate and Government Partners*. Designed to transcend disciplinary boundaries, the symposium featured a diverse range of speakers, from a professor of philosophy to the vice president of a pharmaceutical company. The overarching goal was to promote an integrated approach to research within higher education, and all of the speakers vigorously promoted the idea of enhancing collaborative learning and shared social responsibility. Nonetheless, not all points met with common opinions. In particular, one session addressed some of the challenges to ethical standards presented by recent developments in medical research and the biological sciences, and a heated debate erupted between humanities scholars and scientists regarding the impact of certain corporate research practices on mental health patients. In this regard, the debaters' use of the word 'schizophrenia' struck a chord with me, as I was inevitably drawn back to childhood memories of my mother's depression and involuntary hospitalisation in the 1970s in South Korea. At the time, the influence of American psychiatry on the treatment of mental illness was prominent in many parts of the world. More recently, however, the Americanisation of mental illness has been problematised by the activities of patient advocacy organisations and cross-cultural psychiatrists. These groups and practitioners point out not only that the imposition of Western treatment modalities for mental illness may tend to ignore or obscure cultural differences, but also that the understanding of mental illness is not as clear-cut as the purveyors of 'modern' remedies may appear to believe. What, after all, do we mean by 'sane' and 'insane'? Do we share the same conception of 'madness' regardless of cultural, disciplinary, or personal differences? Scientific research and evidence would appear to point to the universality of conditions typically subsumed under the rubric of mental illness; nevertheless, culture shapes the ways in which people experience and respond to a serious psychiatric diagnosis like

schizophrenia. In my experience, moreover, becoming bicultural and studying such questions from a variety of perspectives may shed light on these differences, but it does not eliminate them.

At the core of my childhood memories stands Dr. Shim, my mother's primary mental health practitioner. A prominent, Western-educated psychiatrist, Dr. Shim had built up a substantial reputation since his return to South Korea. My father maintained a close friendship with Dr. Shim, whose family often visited us on weekends, and their presence was a reminder of my absent mother's confinement. Dr. Shim had two children, one my age and the other younger, and we played together in our backyard while my father and Dr. Shim discussed my mother and the 'progress' of her mental health. I was only about 7 years old, but I tried my best to eavesdrop on their conversations. Although their language was esoteric to my young ears, I gathered clearly enough that my mother was objectified, discussed, silenced and excluded. This recognition was rather felt than rationalised, and this 'feeling' has stayed with me ever since, driving many of my academic concerns, such as my interest in 'hearing' marginalised voices and my exploration of the literature of madness.

Many great writers, such as Gogol, Lu Xun, Silvia Plath, Murakami Haruki and Artaud, have used literature to shape and convey their perceptions of reason's mysterious *other*. Some have replicated, in one form or another, the insights of psychiatry, while others have defended less institutionalised notions or values against the hegemony of the psychiatric worldview. In graduate school, I studied various forms of 'madness' narrative from diverse angles, using material that ranged from a literary work by a practising psychiatrist to a mental patient's personal narrative. At the same time, I began to examine some of the philosophical questions raised by the notion of 'madness' and its opposition to 'reason,' as well as to explore connections between issues in the framing and practice of psychiatry and philosophical examinations of the mind/body dichotomy, the definition of 'humanity,' and possibilities for knowledge in light of universal subjectivity. I also began to look into how the notion of 'madness' has been historically constructed by triangulating relationships among psychiatry, psychology and psychoanalysis and, in turn, to explore the literature of 'madness' from a standpoint that encompassed insights from these and other disciplines.

In the long run, these explorations could be described as my first forays into – as well as the root of my current understanding of – *transdisciplinarity*. Eunsook Hyun, a former professor of education at University of Massachusetts Boston, has described herself as 'an educator and researcher studying human experience for the advancement of humanity' (California State, Los Angeles, 2014). Widely recognised for her contributions to the field, Hyun explains that 'transdisciplinarity does not entail new disciplinary knowledge; instead it involves an inherent and perpetual capacity of simultaneously deepening and extending disciplinary approaches for the improvement of borderless human knowledge and engagement' (Hyun, 2014). In other words, to build a bridge between theory and practice, between the humanities and the sciences, we must work toward openness through dialogue that surpasses existing cultural, disciplinary and personal boundaries. By contrast, ignorance and

apathy destroy people's ability to communicate, cutting off possibilities for transdisciplinary understanding and, ultimately, for progress in any field.

As I sat in the Life Sciences symposium that fall day, reflecting on this realisation and on some of the many problematics and challenges associated with how we understand ourselves and each other, as well as what constitutes or defines our common humanity, I heard in my mind's ear the words of Simon and Garfunkel's 1964 song, *The Sound of Silence* (Simon, 1965):

> And in the naked light I saw
> Ten thousand people, maybe more.
> People talking without speaking,
> People hearing without listening,
> People writing songs that voices never share
> And no one dare
> Disturb the sound of silence.

In the moment of madness, as Michel Camus notes, 'every rationalist will see… only illusion or absurdity. No one is more deaf than someone who does not want to hear. But the question is more radical: someone who does not have the power to hear does not hear'(Camus, 2008). In my case, literature empowered me to hear my mother, across the expanse of time, rather than confining her (memory) to the other side of reason. Most importantly, however, the study of personal narratives and other literary expressions on the theme of madness opened up a therapeutic space for me as I struggled to understand my memories of my mother (unreason) and of her stand-in and surrogate voice: Dr. Shim and his rationality.

To my young ears, Dr. Shim, the voice of science and rationality, seemed to wield enormous power, as the authority of Western science and of the medical establishment placed in his hands every little decision regarding my mother's treatment and well-being. In my mind's eye, moreover, I saw him as the only person who truly wanted to hear my mother and who had the power to do so. This memory inspires and reflects my faith in the power of empathy and humanity to function within the context of the hyper-rational scientific establishment. And yet, I must admit that I may simply have been projecting my own sentiments onto this all-powerful figure of paternalism and reason. In this regard, as a voiceless auditor of discourses regarding my mother's erratic behaviour and confinement, I believe that my faith/projection was facilitated by the fact that Dr. Shim exhibited a genetic condition known as dwarfism. Thus, on the one hand, he stood before me as the all-powerful psychiatrist, the voice of science and reason, and yet, on the other hand, he was a figure nearly as diminutive and as socially marginalised as my mother. For whatever reason, however, even as he spoke to my father about the necessity of my mother's confinement, I always felt that Dr. Shim never quite believed that institutionalisation was the only option, and I cherish the memory that his scientific knowledge and rationality were tempered by humanity and hope.

If knowledge is not self-evident, then what is known is conditioned and limited by the concepts and boundaries of the disciplines within which facts are uncovered and theories are formulated. This proposition is no more true with respect to psychiatry or to science in general than it is for our understanding of what it is to be

human and of what can legitimately pass for humane practices. Moreover, the realms of thought and study known as *humanism* and *the humanities* do not exercise a monopoly – despite their focus on human value, value(s) and creative output – on the understanding of our shared nature or collective worth. In his 1959 Rede lecture, British chemist, novelist and statesman C. P. Snow famously lamented the gap between 'literary intellectuals' and the scientific community, which he predicted would continue to grow (Snow, 1959). Historians and sociologists can debate, if they wish, the extent to which this prediction should be considered accurate, either with respect to divisions within the academy or for society as a whole. For me, however, efforts like those of the organisers of the Boston symposium, of Dr. Hyun, and of my multicultural literature students at an inner-city community college in New York inspire a faith that transdisciplinarity is the natural and authentic mode of human intellectual inquiry, and that individuals from all cultures and academic (or non-academic) backgrounds can work together to create new ways of knowing in which no insight is so cherished or sacred that it excludes other viewpoints or, indeed, so hegemonic or oppressive that it relegates other voices to *the sound of silence*.

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