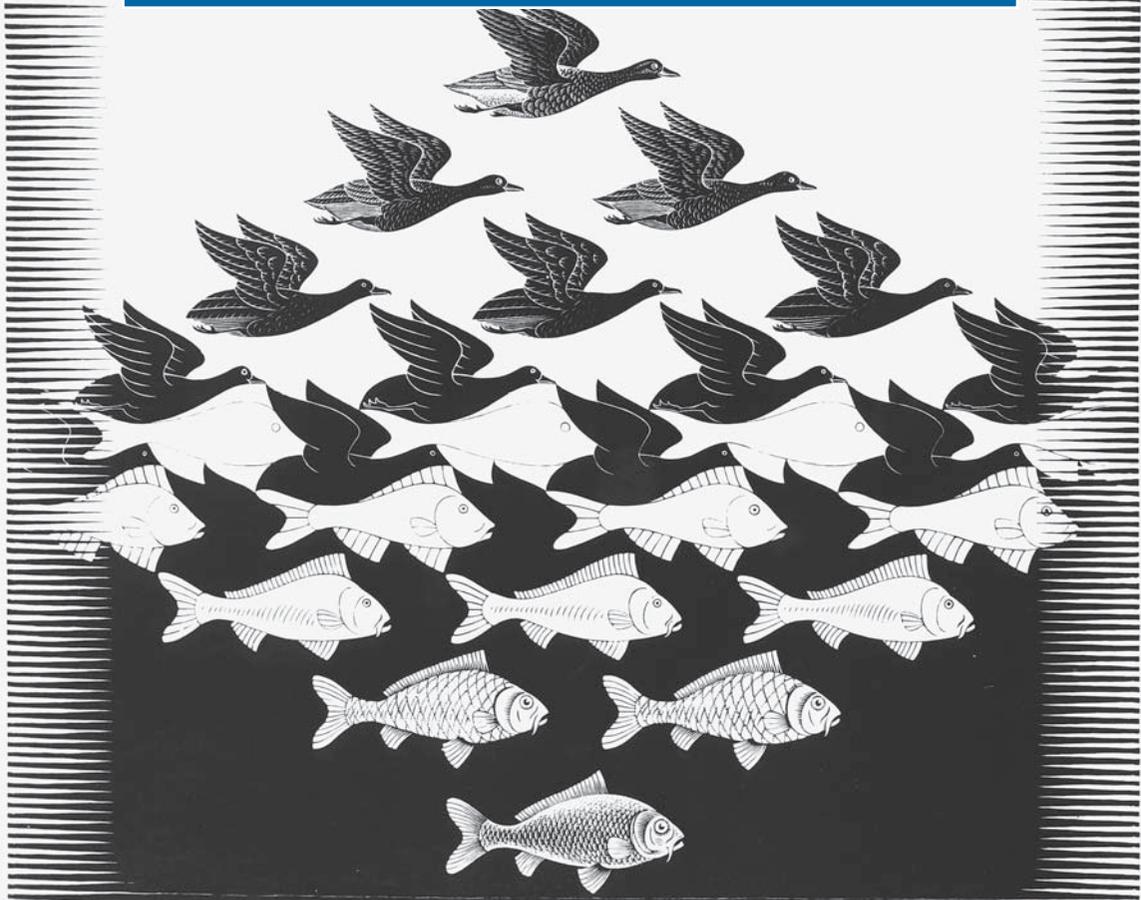


Threshold Concepts and Transformational Learning

Jan H.F. Meyer, Ray Land and
Caroline Baillie (Eds.)



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Threshold Concepts and Transformational Learning

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Threshold Concepts and Transformational Learning

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Pax Inrantibus Salus Exeuntibus. Lintel of threshold (1609),
Canongate, Edinburgh, Scotland

RAY LAND, JAN H.F. MEYER AND CAROLINE BAILLIE

EDITORS' PREFACE

Threshold Concepts and Transformational Learning

INTRODUCTION

At the lower end of the ancient Canongate in Edinburgh there is a worn sandstone lintel over a small seventeenth-century doorway. It bears a Latin engraving on which is inscribed: 'Pax intransibus, salus exeuntibus'. Peace to those who are entering, and safety to those about to depart. It is a modest reminder that a threshold has always demarcated that which belongs within, the place of familiarity and relative security, from what lies beyond that, the unfamiliar, the unknown, the potentially dangerous. It reminds us too that all journeys begin with leaving that familiar space and crossing over into the riskier space beyond the threshold. So, too, with any significant transformation in learning. As Leslie Schwartzman observes later in this volume, 'Real learning requires stepping into the unknown, which initiates a rupture in knowing'. By definition, she contends, all threshold concepts scholarship 'is concerned (directly or indirectly) with encountering the unknown'.

For readers new to the idea of threshold concepts the approach builds on the notion that there are certain concepts, or certain learning experiences, which resemble passing through a portal, from which a new perspective opens up, allowing things formerly not perceived to come into view. This permits a new and previously inaccessible way of thinking about something. It represents a transformed way of understanding, or interpreting, or viewing something, without which the learner cannot progress, and results in a reformulation of the learners' frame of meaning. The thresholds approach also emphasises the importance of disciplinary contexts. As a consequence of comprehending a threshold concept there may thus be a transformed internal view of subject matter, subject landscape, or even world view. Typical examples might be 'Personhood' in Philosophy; 'The Testable Hypothesis' in Biology; 'Gravity' in Physics; 'Reactive Power' in Electrical Engineering; 'Depreciation' in Accounting; 'Legal Narrative' in Law; 'Geologic Time' in Geology; 'Uncertainty' in Environmental Science; 'Deconstruction' in Literature; 'Limit' in Mathematics or 'Object-oriented Programming' in Computer Science.

In attempting to characterise such conceptual gateways we have suggested in earlier work that they are *transformative* (occasioning a significant shift in the perception of a subject), *integrative* (exposing the previously hidden inter-relatedness of something) and likely to be, in varying degrees, *irreversible* (unlikely to be forgotten, or unlearned only through considerable effort), and frequently *troublesome*, for a variety of reasons. These learning thresholds are often the points at which

students experience difficulty. The transformation may be sudden or it may be protracted over a considerable period of time, with the transition to understanding often involving 'troublesome knowledge'. Depending on discipline and context, knowledge might be troublesome because it is ritualised, inert, conceptually difficult, alien or tacit, because it requires adopting an unfamiliar discourse, or perhaps because the learner remains 'defended' and does not wish to change or let go of their customary way of seeing things.

Difficulty in understanding threshold concepts may leave the learner in a state of 'liminality', a suspended state of partial understanding, or 'stuck place', in which understanding approximates to a kind of 'mimicry' or lack of authenticity. Insights gained by learners as they cross thresholds can be exhilarating but might also be unsettling, requiring an uncomfortable shift in identity, or, paradoxically, a sense of loss. A further complication might be the operation of an 'underlying game' which requires the learner to comprehend the often tacit games of enquiry or ways of thinking and practising inherent within specific disciplinary discourses. In this sense we might wish to talk of 'threshold practices' or 'threshold experiences' that are necessary in the learner's development.

This is our third book on the topic of threshold concepts. The first, *Overcoming Barriers to Student Understanding: Threshold Concepts and Troublesome Knowledge* (Meyer and Land, 2006), drew together the early seminal writings and some first disciplinary applications of this approach. It offered, in an exploratory fashion, a tentative conceptual framework and a lens through which to view the pedagogy of higher education anew. After a lively international symposium on this topic in Glasgow, Scotland in the autumn of 2006, a second volume was published. *Threshold Concepts within the Disciplines* (Land, Meyer and Smith, 2008) built and expanded on the first in significant ways. It provided more empirical data concerning the experience of threshold concepts and troublesome knowledge, particularly from the students' perspective. It also extended the range of disciplinary contexts in which thresholds had been studied. This encouraged further work to be undertaken, culminating in a second successful international conference in Kingston Ontario organised by Caroline Baillie in the summer of 2008, from which this third volume has taken shape.

With *Threshold Concepts and Transformational Learning* the empirical evidence for threshold concepts has been substantially increased, drawn from what is now a large number of disciplinary contexts and from the higher education sectors of many countries. The central section of this new volume adds to that evidence base, ranging across subjects that include, amongst others, economics, electrical engineering, education, clinical education, sociology, social justice, modern languages, law, computer science, philosophy, transport and product design, nano-science, mathematics, biology, history and accounting. The authors included here work in colleges and universities in the United Kingdom, the USA, Canada, Sweden, Estonia, Australia, New Zealand, Hong Kong and the South Pacific. The opening section of the volume, moreover, challenges and extends the theoretical boundaries of the thresholds framework in relation to our understanding of transition, liminality and the developmental process of learning, of conceptual

structure, of how students experience difficulty, as well as new dimensions of troublesome knowledge and how we might both render conceptual understanding visible and assess it in a more dynamic fashion. The concluding section contains a substantial body of writing which furthers our understanding of the ontological transformations that are necessarily occasioned by significant learning, the learning thresholds, as we might term them, which might not be strictly conceptual, but are more concerned with shifts in identity and subjectivity, with procedural knowledge, or the ways of thinking and practising customary to a given disciplinary or professional community. We see here too, intriguing migratory instances of the application of threshold theory to other sectors of education, to doctoral education, to professional learning and even to the social analysis of an entire nation in transition.

Taking this into consideration we feel emboldened to see the consolidation of the characteristics of threshold concepts, and of learning thresholds more generally, that were proposed in a tentative fashion in the seminal paper by Meyer and Land (2003). If viewed as a journey through preliminal, liminal and postliminal states, the features that characterise threshold concepts can now be represented relationally. In such a view the journey towards the acquisition of a threshold concept is seen to be initiated by an encounter with a form of troublesome knowledge in the preliminal state. The troublesome knowledge inherent within the threshold concept serves here as an *instigative* or provocative feature which unsettles prior understanding rendering it fluid, and provoking a state of liminality. Within the liminal state an integration of new knowledge occurs which requires a reconfiguring of the learner's prior conceptual schema and a letting go or discarding of any earlier conceptual stance. This reconfiguration occasions an ontological and an epistemic shift. The integration/reconfiguration and accompanying ontological/epistemic shift can be seen as *reconstitutive* features of the threshold concept. Together these features bring about the required new understanding. As a consequence of this new understanding the learner crosses a conceptual boundary into a new conceptual space and enters a postliminal state in which both learning and the learner are transformed. This is an irreversible transformation and is marked by a changed use of discourse. These latter effects – the crossing of conceptual boundaries, transformation, irreversibility and changed discourse – can be characterised as *consequential* features of the threshold concept. These dynamics are summarised in Figure 1.

We would not, however, wish to imply that this relational view has an overly rigid sequential nature. It has been emphasised elsewhere (Land et al, 2005) that the acquisition of threshold concepts often involves a degree of recursiveness, and of oscillation, which would need to be layered across this simple diagram. Furthermore, running throughout this transformational process, in what we might term the 'subliminal' mode, there is often an 'underlying game' in which ways of thinking and practising that are often left tacit come to be recognised, grappled with and gradually understood. This underlying game is a common feature of the processes of entry, meaning making and identity formation typically required for entry to a given community of practice.

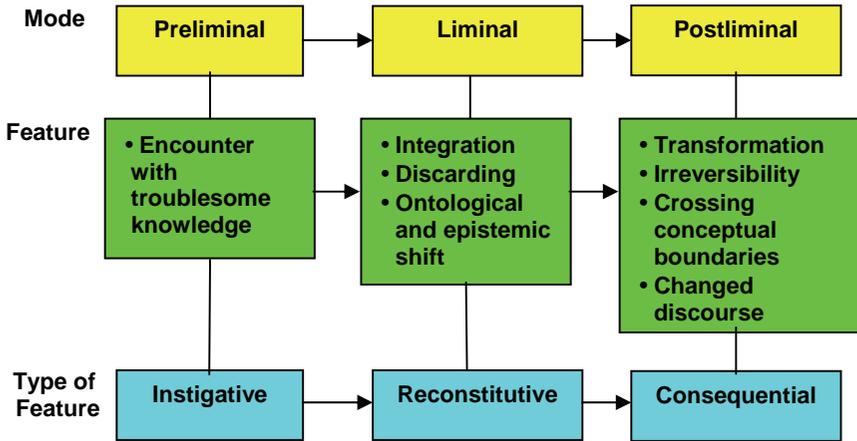


Figure 1. A relational view of the features of threshold concepts.

TRANSFORMATION

It is the nature and process of this transformation or reconfiguring which this volume particularly seeks to address. A number of resonances can be identified between the thresholds approach and work undertaken in the field of transformational learning. The first seminal paper identified correspondences with Mezirow’s work (1978, 1990) on ‘perspective transformation’.

Perspective transformation is the process of becoming critically aware of how and why our presuppositions have come to constrain the way we perceive, understand, and feel about our world; of reformulating these assumptions to permit a more inclusive, discriminating, permeable and integrative perspective; and of making decisions or otherwise acting on these new understandings. (Mezirow, 1990, p. 14)

Mezirow saw transformation being triggered by what he termed a ‘disorienting dilemma’. In his analysis the meaning schemes that we hold concerning a particular phenomenon or situation are unsettled by the disorienting dilemma or challenging perspective and occasion a series of phases, often involving a phase of withdrawal or disengagement prior to a re-engagement in which the integration of the different perspective is integrated. We recognise a number of correspondences here with the instigative effect of threshold concepts, the liminal phase of thresholds theory and the process of integration it entails.

A recurring critique of Mezirow’s work on perspective transformation, however, has concerned its continued emphasis on the rational and analytic nature of the critical reflection that is seen as a primary driver. Boyd and Myers (Boyd, 1989, 1991; Boyd and Myers, 1988) offer an alternative approach, originating in depth psychology, which balances rational reflection with an emphasis on affective

processes. They stress, for example that learners must (affectively) be open to the possibility of transformation in the first place and willing to accommodate 'alternative expressions of meaning' (1988, p. 277). Key phases in the process of transformation as they see it are receptivity, recognition and a final stage of 'grieving' in which there is a recognition that an established pattern of meaning is no longer tenable or valid for future practice. This brings about a point or state of *discernment*. The prevailing perception has to be let go of and eventually discarded so that a process of integration might begin. In their framework this is both a psychological as much as a social process and ties with our own view that in the liminal phase an ontological shift or change in subjectivity accompanies change in cognitive understanding, often as part of a recognition that such shifts are necessary and appropriate for membership of a given community of practice. In our framework the process is also recognised as troublesome and can incur resistance (see particularly Schwartzman, Chapter 2). The shift is also irreversible, a point noted by O'Sullivan and colleagues:

Transformative learning involves experiencing a deep, structural shift in the basic premises of thought, feelings, and actions. It is a shift of consciousness that dramatically and irreversibly alters our way of being in the world. (O'Sullivan et al, 2002, p. 11)

METAMORPHOSIS

Kegan (1982) has drawn attention to the ways in which individuals experience such 'shifts of consciousness' through recurring patterns or phases of stability and change during their lives. Julie Timmermans in the opening chapter of this volume points to the elusiveness and inherent difficulty of examining these transitional phases.

It is these periods of change, these transitions that characterise the learning process, which I find most intriguing. These transitions remain nebulous; however, understanding them is crucial. Cross (1999) notes that 'in developmental theory, the periods of greatest personal growth are thought to lie in the unnamed and poorly-defined periods *between* stages' (p. 262; emphasis in original). We might therefore imagine that the most significant aspect of learning lies not in the *outcomes* of learning, but in the *process* of learning. Understanding this process and how best to facilitate it is thus essential to our work as educators. (Timmermans, Chapter 1)

In her novel *Regeneration*, concerning the trauma and rehabilitation of shell-shocked First World War soldiers, Pat Barker offers a striking, if somewhat unsettling image of transformation. Her character Rivers, a military psychiatrist 'knew only too well how often the early stages of change or cure may mimic deterioration. Cut a chrysalis open, and you will find a rotting caterpillar. What you will never find is that mythical creature, half caterpillar, half butterfly, a fit emblem of the human soul, for those whose cast of mind leads them to seek such emblems. No, the process of transformation consists almost entirely of decay'

(Barker, 1991, p.184). The theme of elusiveness in the process is continued here but also the necessity of discarding the former state. As the American-French writer Anais Nin observed, 'To change skins, evolve into new cycles, I feel one has to learn to discard. If one changes internally, one should not continue to live with the same objects. They reflect one's mind and the psyche of yesterday. I throw away what has no dynamic, living use.' (Nin, 1971, p. 26). But as Rebecca Solnit points out, as yet, 'We have not much language to appreciate this phase of decay, this withdrawal, this era of ending that must precede beginning. Nor of the violence of the metamorphosis, which is often spoken of as though it were as graceful as a flower blooming ... The process of transformation consists mostly of decay and then of this crisis when emergence from what came before must be total and abrupt'. (Solnit, 2006, pp.81–3). The chapters that follow in this volume attempt just that, an articulation of what such transformation – literally a going beyond one's extant form – entails. And, as we will see in the following pages, the transformation will always be determined to some extent by its disciplinary, or interdisciplinary, context. As Crainton emphasises:

Transformative learning is not independent of content, context, or a discipline. It's not an 'add on' to a course. It is a way of making meaning of knowledge in a discipline in a way that students don't passively accept and believe what they are told or what they read, but rather engage in debate, discussion, and critical questioning of the content. Promoting transformative learning is a part of 'covering' content. (Kelly and Crainton, 2009, p. 1)

Transformative learning, she argues, can be promoted by using 'any strategy, activity, or resource that presents students with an alternative point of view'. These might include 'readings from different perspectives, field experiences, videos, role plays, simulations, and asking challenging questions' all of which have the capacity to effect transformative learning. 'The educator needs to create an environment in which critical reflection and questioning norms is supported and encouraged' (ibid). What would seem to be the enemy of transformative learning, however, is didacticism or any form of coercion. This is persuasively expressed by the American theologian and teacher Walter Brueggemann. The elegance of his argument merits quoting in full:

We now know (or think we know) that human transformation (the way people change) does not happen through didacticism or through excessive certitude but through the playful entertainment of another scripting of reality that may subvert the old given text and its interpretation and lead to the embrace of an alternative text and its redescription of reality. Very few people make important changes in their description of the world abruptly. Most of us linger in wistfulness, notice dissonance between our experience and the old text, and wonder if there is a dimension to it all that has been missed. Most of us will not quickly embrace an alternative that is given us in a coercive way. Such coercion more likely makes us defend the old and, in general, become defensive. Victor Turner noted that there is an in-between time and place in social transformation and relocation, which he termed

liminality. Liminality is a time when the old configurations of social reality are increasingly seen to be in jeopardy, but new alternatives are not yet in hand. What we need for such liminality is a safe place in which to host such ambiguity, to notice the tension and unresolve without pressure but with freedom to see and test alternative textings of reality. (Brueggemann, 1995, pp. 319–20).

EXTENDING THE THEORY

The opening section of this volume contains six chapters which in different ways move forward our thinking about thresholds. **Julie Timmermans** (Chapter 1) situates the characteristics of threshold concepts within a developmental framework. Informed by Kegan's (1982) interdisciplinary Constructive-Developmental Theory and recognising 'the equal dignity' of both cognition and affect, she examines the process of epistemological transformation triggered by threshold concepts. Seeing each stage within the transformational journey as a kind of new (evolutionary) truce, she draws our attention to the nature of the (alternative) 'commitments', both cognitive and emotional, that may be held by learners. These 'may provide educators with rich insight regarding learners' unwillingness to change' and their reluctance to let go of a sense of integrated selfhood. In asking 'What type of learning leads to development?' she draws attention to the 'complex continuum' of emotional responses likely to be found within the liminal space.

That some learners 'open up,' while others clearly get 'stuck' ... may signal to us as educators that the epistemological transition being instigated by a threshold concept lies *beyond* the learner's zone of proximal development (Vygotsky, 1978). That is, it lies too far beyond what the learner may achieve when guided by more skilful others. These variations in response to teaching caution us to be attuned to variations in the ways that learners are making meaning.

In addition to proximal influences this leads her in her conclusion to emphasise the 'multiple layers of context', such as religion and family, that may shape individuals' epistemic beliefs. In a timely note of caution to discipline-based teachers in their attempts to 'teach' threshold concepts she calls for increased attention to the learning *process* and a tolerance of variation in learners' cognitive and affective responses.

From the perspective of phenomenological analysis **Leslie Schwartzman** (Chapter 2) challenges the current theoretical premises of the threshold concepts framework, arguing for a rigorous transdisciplinary theoretical foundation predicated on the scholarship of rupture in knowing (Heidegger, 1927) and the responses, both reflective and defensive, that might ensue (Segal, 1999). A more productive approach to understanding how students negotiate and traverse liminal spaces, she argues, and to how we might better assist them in this activity, is to be found 'in universal human patterns of encounter and response to the existentially unfamiliar (what appears initially as the unknowable unknown) rather than focusing on

variations arising from the sundry disciplinary contexts of learning, or from ‘individual inadequacies’. Her analysis leads to a significant contrast in how we might define transformational learning as distinct from deep learning. As a result of deep ‘cumulative’ learning, she argues:

one switches dynamically – within the same field of consciousness – among thematic foci, with correspondent restructuring of thematic fields (Booth, 1997, p. 144). The total set of elements in the field remains constant, while boundaries among the thematic foci, the thematic field, and the margin become fluid; and component elements shift between adjacent domains. The mechanism of dynamic switching among extant elements corresponds to *reflection; the operation corresponds to refinement and clarification of one’s extant meaning frame.* (Editors’ italics).

In contrast, the outcome of transformative learning, she contends, is that:

the contents of the field of consciousness change. Elements formerly not found in any domain of consciousness, possibly including component parts of elements formerly classified as non-decomposable, now occupy the thematic focus or reside in the thematic field; and some elements formerly found there are now relegated to the margin. The mechanism remains mysterious and corresponds to *reflectiveness; the operation, which results in a different population in the field of consciousness, corresponds to reformulation of one’s meaning frame.* (Editors’ italics).

In clarifying this nice distinction, she questions whether the proponents of threshold concepts in their teaching are adopting the latter approach, bringing new meaning to bear upon existing experience (which the Meyer and Land framework would seem to condone), or the former approach, which would seem to be attempting the reverse.

The nature of troublesome knowledge is given a further dimension in **Aidan Ricketts’** application of the threshold concepts framework to the teaching of Law (Chapter 3). In relation to transformational learning he points out that ‘transformative experiences may enhance a student’s critical awareness, but this should not be assumed; in some cases the nature of the transformation may actually reduce the scope for critical thinking’. He coins the term ‘loaded knowledge’ to refer to the manner in which increased access to and facility with the ways of thinking and practising of a given community of practice (in this case the legal profession) may have a reductive effect more generally in terms of occluding other forms of knowing. The particular instance given here is the way in which students of legal education might find access to certain forms of critical knowing difficult within their curriculum. This is not inevitable but the practice of legal education needs to be carefully designed, he argues, to ensure the inclusion of critical perspectives, including critique of ‘the very discipline they have come to study’. In a study of much wider applicability to all disciplines he concludes that it ‘appears inevitable that studying law will involve encounters with troublesome and counter intuitive ideas and with loaded knowledge and that one way or another law students are

likely to be changed by the experience. The challenge for educators, is to decide whether education should be openly self critical even of its own discipline or simply impose closed intellectual and value systems upon its students.'

If the troublesome transformations occasioned by threshold concepts require a rather different way of looking at the curriculum, then it follows that such transformations will require a more nuanced and generative model of assessment. This would help us identify variation in progress and understanding at the preliminal, liminal, postliminal and subliminal stages of conceptual and epistemological fluency. **Ray Land** and **Jan Meyer** (Chapter 4) argue for a dynamic model of assessment, acting more like a 'flickering movie' of a student's progress along the transformational journey and indicating how structures of a student's understanding might be changing rather than a stationary, one-off 'snapshot'. They argue that the threshold concepts framework points to variation in progressive stages of a student's journey towards, through, and beyond particular conceptual gateways. They ask how we might construct a meaningful assessment process for students for whom, in many instances, what is to be assessed lies outside their prior knowledge and experience, or beyond their ontological horizon. The threshold concept has not fully 'come into view'. This might move us on from traditional assessment regimes in which a student seems to be able to produce the 'right' answer while retaining fundamental misconceptions. They seek an insightful conceptual basis for developing new and creative methods of assessment and alternative ways of rendering learning (and conceptual difficulty) visible. This in turn can inform course (re)design in a generative and sustainable fashion.

Ian Kinchin, **Lyndon Cabot** and **David Hay** (Chapter 5) demonstrate the kind of approach Land and Meyer advocate, as a means of rendering learning and patterns of understanding 'visible' in professional clinical settings such as dentistry, medicine and nursing. In a piece entitled 'Visualising expertise' they too seek a quality of dynamism – 'a dynamic transformation of knowledge structures, relating competence and comprehension'. They represent the gradual transformation of learners' understanding through concept mapping techniques that render explicit current states of knowing and conceptual linkages that can be represented by 'chains' of practice and 'networks' of understanding. Over a given period of time the structures of meaning-making can be seen to change, with new elements being integrated, others being let go of or discarded, whilst further elements enter understanding but remain unintegrated. In affective terms however, the adoption of expertise-based pedagogy requires a certain confidence and courage on the part of teachers and practitioners both to share their knowledge, and the gaps in their own understanding. This approach often surfaces understandings and misunderstandings which previously might have remained tacit. 'The knowledge structures approach, facilitated by concept mapping tools', the authors contend, 'provides a mechanism to go beyond making learning visible, towards making it tangible (i.e. not only can it be seen, but it can also be manipulated to support development).'

To conclude the opening section on theoretical aspects of threshold concepts **Jerry Mead** and **Simon Gray** (Chapter 6) focus attention on the use of the term *concept* in thresholds parlance in order 'to provide a more secure footing, in the

form of a model of conceptual structure on which the term “concept” in “threshold concept” can rest’. They address this issue from a disciplinary perspective, viewing the identification of threshold concepts as something reached consensually over time within the disciplinary community – ‘disciplinary constructs that have emerged from the crucible of disciplinary scrutiny as definable abstractions’ and with any personal connotations discarded. Hence the role of an educator within a given discipline is to align the structure of students’ evolving *personal* conceptions with that of the agreed *disciplinary* conception. They point out that the personal effect of threshold concepts on learners can only be significant ‘if the way someone thinks from inside a discipline is different from the way someone outside of the discipline thinks’. But here they take issue with the current threshold concept definition pointing out that ‘it leaves threshold concepts isolated from an ontological point of view’ without reference, from the student perspective, to other concepts in its disciplinary context. As they put it, ‘the idea that a threshold concept “exposes the previously hidden interrelatedness of something” implies that there must be other relevant concepts, i.e., the things that are “interrelated”’.

To address this they set out to provide, within a disciplinary context, a conceptual structure, a ‘more secure footing’, within which threshold concepts ‘can be localized’. They employ Perkins’ notion of a *concept episteme* as ‘the system of ideas or way of understanding that allows us to establish knowledge of the concept’. They name the kind of conceptual structure they produce a ‘disciplinary concept graph’ (DCG). This can facilitate student understanding of concepts in a discipline, and, they argue further, the five threshold concept characteristics can be localized within such concept graphs. Using atomic theory as illustration, they seek to identify the concepts that are central to a discipline and which serve as the ‘targets of the questions, problems, and judgements’ that arise in that discipline. They coin the term *condensation point* to encapsulate ‘a unifying and generalizing concept that is definable within an episteme and condenses out of the associated knowledge space a fundamental disciplinary idea or capability’.

CONCEPTUAL TRANSFORMATIONS

The central section of this volume offers a rich variety of instances of important transformations within the learning of particular disciplines and demonstrates how tutors have tried to understand the kinds of conceptual difficulty faced by their students. In the geosciences **Kim Cheek** (Chapter 7) discusses three possible factors that account for why the notion of ‘deep time’ proves so troublesome for learners, namely conceptions of conventional time, understanding of large numbers and the student’s current state of subject knowledge. She points out the alien and counter-intuitive understanding involved in grasping ‘that rocks can behave plastically, continents move, and the mountains we visit will one day be gone’. Much of this difficulty stems from the fact that though deep time is not a qualitatively different construct from a general concept of (conventional) time, it nonetheless requires a logical extrapolation ‘to events and processes that are out of the realm of human experience by orders of magnitude’. The processes involved occur at very

slow rates and hence are imperceptible to human observers. Such temporal understanding is not within the horizon of the student's experience and neither is the scale of the numbers necessary for such understanding. Issues of scale require an ability to work in different units of measure. The capacity to work in a unit of millions of years, and to differentiate a million year unit from a thousand year unit, 'enables a person to meaningfully conceive of many geologic processes'. However even adults, it seems, will resort to a more logarithmic scale (as opposed to linear mapping) when confronted with such large numbers. A subtle and potentially complex effect arises from the student's prior subject matter knowledge, and their prevailing ways of thinking and practising, i.e. can a student place a particular species in a sequence of events if she doesn't know what it is?

We may be inferring an understanding (or lack thereof) about deep time when it's really something else directly related to specific geologic knowledge [or even analogical reasoning from some other subject area with which the student is familiar] that's accounting for student responses.

In Chapter 8 **Monica Cowart**, a philosopher, seeks an explanation of 'how to identify, deconstruct, and integrate philosophy-specific threshold concepts so that students can develop disciplinary specific thinking'. What does it mean, she asks, to think like a philosopher? What languages games, rituals, customs and methods come into play? An awareness of threshold concepts, she argues, can guide the decisions professors have to make in terms of prioritising what should be taught in philosophy programmes, how it should be taught and how it might be best assessed. She maintains that philosophy's three sub-disciplines of ethics, epistemology, and metaphysics are the key to recognizing 'core' threshold concepts within the discipline. These core philosophical threshold concepts exist at the *intersection* of the three sub-disciplines because these concepts raise questions within each sub-discipline. This positioning is significant as:

to truly have an understanding of core philosophical threshold concept x, you must understand the questions threshold concept x raises in metaphysics, ethics, and epistemology. To simply understand the questions the concept raises in only one of these areas will not result in an accurate understanding of the concept.

The location of the concept at the intersection however, adds to its complexity, and hence potential troublesomeness to students. The author examines a specific example of such an intersectional threshold concept in the notion of 'personhood', before moving, in the second part of the chapter, to consider how this concept might be taught and learned. Utilising the specific epistemes (or philosophers' tools) of thought experiments, the Socratic method, and analytic deconstruction, she outlines a pedagogical approach to the teaching and learning of personhood predicated on principles of active learning. This involves the preparation of and participation within a formal team debate, and includes the design of an assignment 'that will enable students to showcase in the public domain knowledge of personhood through the rule-governed use of the discipline-specific epistemes, which enable the exploration of the concept'.

Questions of intersection and the importance of prior learning raised earlier by Kim Cheek, occur again in Chapter 9 where **Rosanne Quinnell** and **Rachel Thompson** consider the points where students are likely to encounter difficulty as they practise academic numeracy in the life sciences and medical statistics. Far from being a transferable skill, numeracy, they suggest, for many students in their field, can become a transferable anxiety. ‘A grasp of numeracy is essential to understand the abstraction of the biological phenomenon; failure to appreciate that patterns in biology can be represented in abstracted mathematical forms inhibits students’ understanding of scientific practice’. The authors present an experiential learning cycle in science that mirrors their practice of attempting to understand biological phenomena. They map on to this cycle where numeracy and literacy skills intersect, and the points at which they observe that student engagement begins to wane, ‘the moments when students experience obstacles to learning’. It emerged that ‘most of these points of uncoupling involved numbers and formulae’, leading the authors to infer that ‘for numerophobic students, this is a key factor affecting student progress through the liminal space in understanding a threshold concept’. Following a process of *unpicking* of numeracy issues based on tutors’ and students’ experience, the authors identify three main overarching threshold concepts in statistics within their field – the ‘sampling distribution’ lens, the ‘strength of evidence’ lens (including hypothesis formation and testing), and the ‘applicability of evidence’ lens – with the associated basic and threshold concepts that underpin each of these. Two case studies are described in which interventions were made to help students cope with these learning thresholds and overcome anxieties regarding numeracy. In the first the need to explain the concepts using numbers was removed, and with it the concomitant numerophobia, and students were enabled ‘to find another route through this difficult learning moment’. In the second study tutorials were constructed around a ‘numeracy diagnostic’ focused on confidence. The aim of this diagnostic was to pinpoint where numeracy was problematic and where students were uncoupling themselves from the learning process. Interestingly the students who engaged most fully with this challenging task were those least confident in their responses. Both of these approaches have proved fruitful in identifying future paths for skills development and overcoming barriers.

Two further chapters in this section also examine threshold concepts within biological sciences. **Pauline Ross** and her colleagues **Charlotte Taylor**, **Chris Hughes**, **Michelle Kofod**, **Noel Whitaker**, **Louise Lutze-Mann** and **Vicky Tzioumis** (Chapter 10) explore the nature of student misconceptions in biology. A range of candidates are identified as potentially troublesome content knowledge, including cellular metabolic processes (e.g. photosynthesis and respiration), cellular size and dimensionality (surface area to volume ratio), water movement (diffusion and osmosis) genetics (protein synthesis, cell division, DNA) evolution, homeostasis and equilibrium. In addition to this however the authors identify a number of procedural threshold concepts such as energy, variation, randomness and probability, proportional reasoning, spatial and temporal scales, and thinking at a submicroscopic level. Students lack of such procedural or processual abilities,

compounds the inherent difficulty in the subject content knowledge, causing misconceptions. The authors argue that employing thresholds as a heuristic in this fashion permits insights not gained from the existing misconception and constructivist literature, and raises a number of questions for the development of teaching and learning in biology. On the assumption that threshold concepts reflect differences in ways of thinking and practising between acknowledged experts inside the subject and novices on the periphery, they argue that students should be encouraged to acquire facility with the procedural thresholds mentioned above to facilitate their crossing of portals and hence develop a better understanding of hitherto troublesome knowledge. This will enable us to understand 'whether students can subsequently transfer this thinking process to aid their understanding of other similarly difficult content (that is, to see if they have learnt how to cross unfamiliar thresholds)'.

Within biological sciences the capacity to formulate an experimental design and a testable hypothesis within it can be seen as a crucial aspect of how biologists 'think'. **Charlotte Taylor** and **Jan Meyer** (Chapter 11) investigate the processes through which students acquire this capacity for 'apprehending the multivariate complexity of the biological world and hypothesising within it phenomena amenable to experimental verification'. In keeping with threshold theory this apprehension contains an *ontological* dimension and its own *discursive* modes of 'reasoning and explanation'. The authors point out that although higher order abstract dimensions of biological thinking are an indispensable part of this process, and that in discursive terms, 'the mechanics of defining a precisely worded testable hypothesis require an appreciation of the appropriate language and symbolic representations', nonetheless these requirements can to some extent be acquired in a rote manner, with testing procedures for the hypothesis gained through recipe-like formulae. It is the *integration* of ideas, they suggest, which is key, and which:

demonstrates a transformed understanding, requires a sophisticated articulation of the scale, dynamics, complexity, variability and role of probability in explaining the system under investigation. Dealing with this in the paradigm of scientific thinking encompasses the threshold.

These concerns have led to a consideration of the experience of students in the preliminal space. The students often have limited prior experience of the complexity of biological systems, and encounter scenarios and processes not easily amenable to observation at the molecular or chemical level. Engagement and ownership become the critical factors, with a need for students 'to have the opportunity to take ownership of the process of observation, explanation and hypothesis creation, for successful understanding to occur.' The rich sources of data from students' thinking, as they engage in the process of hypothesising and document their move into the liminal phase, signal the need for significant changes in our approaches to the teaching of biology.

Through a careful analysis of written answers by students in economics examinations **Peter Davies** and **Jean Mangan** (Chapter 12) consider the role of threshold concepts in assessing the progression of students' understanding in economics.

Drawing on both threshold theory and variation theory (Pang and Marton, 2005), they argue that the conception of a phenomenon that is described by a basic concept within a discipline can ‘only be attained once a learner is able to use a super-ordinate threshold concept to organise their conceptual structure’. However, for learners to be able to organise their thinking through a threshold concept, they continue, they will also need to use certain associated ‘procedural concepts’. As they put it:

If a discipline threshold can be represented as a ‘portal’, then procedural concepts provide the means by which the structural form of the portal can be assembled: the guidance that directs the way in which pieces are put together.

Taking an example from economics they argue that without the ‘modelling’ (or procedural) concept of equilibrium, the set of basic concepts needed to grasp a model of the determination of the level of national income – concepts such as the distinction between injections and withdrawals, savings and investment, stocks and flows, real and nominal values – cannot be made ‘to act in concert to produce a coherently structured understanding of an economy as a system’. On the other hand, they suggest, if a student *is* observed to be employing a modelling concept in this way to mobilise one or more basic concepts, then it is probably reasonable to infer that he or she is engaging in the process that can lead them towards incorporating a threshold concept.

The authors’ proposition that ‘more complex conceptions of a phenomenon rely on the transformation of basic concepts by disciplinary threshold concepts that integrate a learner’s conceptual structure’ gives rise to significant assessment issues in a massified system of higher education where tutors are faced with large numbers of scripts and seek salient cues to student understanding as a kind of shorthand to facilitate speedier techniques of marking in large first and second year classes. This can prove dysfunctional however. The authors predict that, for example:

when students are introduced to a concept like ‘the circular flow of income’ they begin to use the language of a disciplinary conception (such as ‘multiplier’) well before they have developed the kind of understanding which an expert might infer from use of such terms. This creates an assessment difficulty in the context of ‘large-scale’ assessment.

The model of the development of a threshold concept provided by the authors here identifies the understanding of procedural concepts, such as equilibrium mentioned earlier, as critical. The evidence gained so far in this enquiry points to this conclusion, though there is a need for further empirical study to confirm these findings.

In a further empirical study drawn from economics **Martin Shanahan, Gigi Foster and Jan Meyer** (Chapter 13) build on the earlier observation by Meyer and Land (2006) that individuals proceed at varying rates across conceptual thresholds and exhibit varying states of liminality. These authors also utilise a combination of threshold theory and variation theory to assess the degree of tacit knowledge that

students bring to a threshold concept in the preliminal state, for, as with prior content knowledge, students may vary greatly in the amount of prior tacit knowledge they have of particular threshold concepts. The authors then tread new ground in researching whether an association exists between threshold concept understanding and *attrition* from a course of study. The focus of their study is an examination of the association between students' observed grasp of certain threshold concepts in economics at the start of a semester and their likelihood of leaving an introductory microeconomics course in that same semester. An interesting secondary consideration of their study is the hypothesis that an important ontological shift is also required on the part of students – a shift in which one comes to view oneself as a bona-fide student learner – as 'a necessary preliminary stage of thinking that must be attained by students before discipline threshold concepts become relevant'. In terms of attrition they speculate that it is the students who fail to make this shift that are the most likely to leave the course early. Moreover, they suggest that 'the impact of preliminal knowledge of economic threshold concepts is only relevant once this transformation is made'. The findings of the enquiry lead the authors to believe that, though the factors associated with student attrition are many, an important conceptual portal that many students must negotiate as a mark of commitment to their studies is that of 'self-identification as a university student'. An interesting secondary finding is that, once a student has committed to study (roughly completion of the first semester of teaching), then variation in students' grasp of discipline-based threshold concepts may be associated with an individuals' preparedness to sit the exam. Self-identification as a university learner is a clear determinant of student retention in these findings, although, as the authors indicate, 'the distribution of previously acquired threshold concepts does appear to be systematically related to other differences that place students at risk of failing'.

Ference Marton, a leading proponent of variation theory, recently commented that:

The one single thing that would improve the quality of teaching and learning in higher education would be if academics in different disciplines took time to meet together and discuss what they should be teaching in their subject, and how they should be teaching it. This is something that Variation Theory has not done, and I think the Threshold Concepts approach encourages people to do this. In my opinion there is absolute complementarity between Threshold Concepts and Variation Theory. (Marton 2009).

In a significant example of academic specialists engaging in exactly such a conversation, and also reaching conclusions on the possible complementarity between Threshold Concepts and Variation Theory, **Michael Flanagan, Philip Taylor and Jan Meyer** (Chapter 14) examine the ways in which 'transmission lines', a threshold concept in electrical engineering may come into view quite differently depending on whether the concept is introduced from a perspective of large-scale systems (power engineering) or small-scale systems (instrumentation and electronics) and whether students are envisaging power transmission along overhead power lines or along coaxial cables. In experimental tests in the former, students struggled with

the notion of *reactive power*. As a complex idea of what is in effect ‘powerless power’, requiring the use of (imaginary) complex number, students found this both counter-intuitive and ‘mentally awkward’. With small-scale systems students struggled similarly with the idea of *characteristic impedance*. Students in both engineering contexts were left frustrated, perplexed and confused, and, as we have seen elsewhere in threshold analyses, resorted to ‘mimicry’ as a coping strategy. For some students, the authors point out, it became clear that ‘elaborating the simpler concept of current flow down a wire into a mathematical treatment of the associated electromagnetic field was troublesome and counter-intuitive especially as the concept of the electric or magnetic field itself is troublesome’. Indeed, to exacerbate the problem, the authors comment that ‘fields’ may operate as threshold concepts in their own right. One source of the conceptual difficulty was that the students found it difficult ‘to envisage any associated physical reality in the calculations of the properties of a travelling electromagnetic wave (the signal travelling along the line) using complex arithmetic’. In terms of a ‘spiral curriculum’ (Bruner, 1960), and an analysis of how earlier preparation in the simplified equations of high school physics might have adversely affected subsequent coping with a more complex university curriculum, the authors conclude that such earlier learning presented three potential barriers to learning. Firstly, the concrete had preceded the abstract; secondly, the detailed had preceded the general; and thirdly, perception was now preceding cognition. The authors’ view was that each of these concepts of reactive power and characteristic impedance were in fact acting as portals to usher students into a far more complex liminal space involving understanding of electromagnetic theory. A number of issues follow from this. One practical problem is that students are not in a position realistically to experiment with large-scale power systems. Though recent computer simulation packages open up interesting and potentially helpful possibilities in this regard there is the danger of students performing calculations in a ‘ritualistic’ fashion without understanding (Perkins, 1999). Moreover, in relation to possible complementarity between threshold concepts and variation theory the authors observe that:

If a troublesome concept is flagged by students and/or staff that is, in reality, a portal to a much more complex liminal space there is a risk that a variational approach constructed around this troublesome concept alone may not effectively aide the students in mastering their difficulties.

In terms of the kinds of knowledge that engineering students should encounter during an engineering degree, the study of learning thresholds in relation to electromagnetic theory raises more far-reaching issues of where applied physics might end and electronic engineering begin, and whether engineering graduates are defined by their skills or their particular industry.

In Chapter 15 we encounter another ‘disciplinary conversation’ taking place. **Lynda Thomas**, with her colleagues **Jonas Boustedt**, **Anna Eckerdal**, **Robert McCartney**, **Jan Erik Moström**, **Kate Sanders** and **Carol Zander**, report on the findings of a multi-national, multi-institutional project that has now been under way for four years and which is seeking an empirical identification of threshold

concepts in the fast-moving and ever-changing domain of computer science. This systematic and detailed enquiry has evolved to date through five phases of enquiry, embarking initially on an extensive review of the computing curriculum literature, and direct interviews with teachers of computing. The characteristics originally identified by Meyer and Land (2003) were employed as the focus of research questions. This shifted in the second phase to interviewing students nearing graduation on their experience of two main threshold concepts of *object-orientation* and *pointers*. As the students' responses tended to emphasise difficulty, a subsequent research question explored the strategies used by students to become 'unstuck'. This opened up a third phase of enquiry, examining the nature of liminality in terms of the student experience of these troublesome concepts. In the fourth, the methodology shifted to the use of conceptual mapping in order to render visible and better gauge the students' understanding of the central ideas of object-orientation, and of what the students themselves regarded as central priorities. The most recent phase, very much in keeping with the theme of this volume, has analysed student biographies to illuminate the transformative aspect of threshold concepts. Here students were asked to identify and describe a computing concept that 'transformed the way they see and experience computing'. The use of 'lure stories' (Schulte and Knoblesdorf, 2007) brought into view a number of other potential thresholds, many of which are related to the key computing science theme of *abstraction*, and which threw light on how the overall concept of abstraction is manifested in students' learning. The authors' point however that

whether abstraction is a threshold concept; contrary to expectation, it seems unlikely. Rather, it seems likely that there are a number of threshold concepts in computing that could be classified as abstractions of one form or another.

The student biographies, taken from students in three different countries, identified a range of potential candidates for concepts that had transformative potential. These included *modularity*, *data abstraction*, *object-orientation*, *code re-use*, *design patterns*, and *complexity*. The authors concluded from this wide ranging and large study that changing their data-collection techniques had affected their results. In the light of the link with variation theory discussed earlier they also found considerable individual variability in student experience, and that the students described more specific thresholds than instructors. In a statement which has interesting implications for those researching transformation and learning thresholds in other disciplines the authors found that:

Whether or not students experience different thresholds, they place greater significance on different transformations. We observed many potential threshold concepts on a single occasion only; we observed some that seemed highly dependent on a particular context. Coming up with an exhaustive 'catalogue' of threshold concepts in a discipline may be impractical. More important, the sequences of partial understandings that students exhibited as they were learning a concept were quite variable: no single path. Rather than seeing a progression of deeper understandings in a concept, we saw different levels of understandings of different parts.

Eun-Jung Park and **Greg Light** (Chapter 16) sought to identify a threshold concept in studies at the atomic and molecular levels in the relatively new field of nanoscience. Their study (after Davies, 2006) adopted both top-down (expert-focused) and bottom-up (student-focused) methods. These methods included 'the construction of concept maps and an interview with the expert (professor), and the construction of pre- and post- course concept maps and the completion of a linked open-ended survey by the students'. Interestingly both methods tended to converge on one particular potential threshold concept, *surface area-to-volume ratio*, as a candidate for nanoscience, at least within this taught programme. Of this threshold concept the expert professor commented:

Well, *surface-to-volume ratio* is the threshold concept, because you can't get down here (the nano level) without accepting the fact that really tiny particles have large surface-to-volume ratio... So take a gram of something and keep chopping it up until you get down to nano-particles. And what you see is the surface area just goes through the roof. So this is enabling... because, without that, you can't do this. So this would be a threshold concept.

The professor also identified eleven key, or important, concepts within this field. The survey of forty-two student pre- and post-course concept maps revealed thirty-eight further concepts, in addition to the professor's original eleven. The authors employed a phenomenographic approach to analyse the experiential component of these maps to identify variation in the ways students experienced the troublesomeness of the concept. This revealed 'a hierarchical continuum of patterns of understanding, each more complex and inclusive of the preceding patterns' which produced an outcome space comprising the following five patterns of student understanding: 1. Isolated, 2. Unconnected, 3. Detached, 4. Limited, and 5. Integrated. The key aspect of variation characterising the most complex pattern ('Integrated'), and the pattern most closely reflecting the expert's pattern, was the recognition of the central role of *surface area-to-volume ratio* in the integration of the key nano domain concepts. Both expert and student responses reported this as an integrative concept, whilst two thirds of the students selecting this threshold concept also experienced a change of understanding during the course towards a more sophisticated pattern. In consequence the authors conclude that their study presents 'preliminary evidence that a meaningful understanding of *surface area-to-volume ratio* critically contributes to students' ability to integrate other key concepts in the nano-domain'.

Interestingly, however, the concept *surface area-to-volume ratio*, though selected as a threshold, was not regarded as a particularly troublesome or difficult concept to understand. The authors suggest this might be owing to the fact that 'troublesomeness does not necessarily reside directly with the threshold concept but rather in the integration of the domain cluster of concepts within the student's understanding'.

They also report that the representation of student understanding gained from concept maps, though useful, is not a sufficiently rich source of data in itself for analysis and interpretation of student understanding, and their ongoing study will employ subsequent use of interview data.

In the final illustration of conceptual transformation **Marina Orsini-Jones** (Chapter 17) addresses a threshold concept frequently encountered by languages students. This is 'the overarching structure of a sentence', often referred to in linguistics as the *rank scale concept*. The overall concept is formed from acquisition of a range of grammar categories; students must master each of these fundamental grammar 'milestones' before being able to grasp the overall concept. The author proposes that 'encouraging students to actively engage with metacognition relating to the threshold concept identified while they are in the liminal state can also contribute to their "readiness" to cross it'. The data for the study was drawn from a two year action research analysis which highlighted that many languages students experience 'grammar anxiety', despite the aspirations of many of the group to become English as a Foreign Language (EFL) or Modern Languages (ML) teachers, who routinely have to explain grammar to their students.

Active engagement with metacognition relating to grammar anxiety and the *rank scale concept* was fostered through the design of a 'metareflective socio-collaborative assessed task' to help students overcome the troublesome knowledge, though, the author acknowledges, 'it remains a contested notion whether or not engaging in metacognitive grammatical activities can enhance language learning and whether or not a focus on linguistic form can benefit language skills in the target language studied'. The assessed task, *The Group Grammar Project*, is complex and involves students in a range of activities including web site development, group presentation, anonymous self- and peer-assessment, and the writing of an individual reflective report on the project. In both years of the action research it emerged that the most troublesome elements in the overall *rank scale* threshold concept tended to be complex sentences (relationships and identification of verbs); clauses (identifying subject-verb-object); phrases (confusion with clauses); and word classification (adverbs and prepositions). Barriers to learning the threshold concept included unfamiliar terminology that invoked student resistance and conservatism, prior (mis)knowledge of terms, requiring an 'undoing' of pre-conceived definitions of the grammar categories involved, prior knowledge, reliance in group work upon peers who found the grammatical categories 'troublesome' but decided nevertheless to take a lead in the analysis of the sentences, misunderstanding of the concepts and lack of ability to ask lecturers for help; lack of motivation towards grammar and the module, lack of reinforcement or support by other tutors teaching languages, and feelings of grammar fear or inadequacy. Lack of awareness of underlying grammar principles emerged as the main concern for the students interviewed, particularly the native English ones. However a range of strategies were identified as assisting students to overcome the difficulty in understanding the rank scale concept. These included collaborative group work; demonstrating initiative and asking for help; confidence building via grammar analysis; practice via diagnostic tests; inspiration from peers; explaining grammar to peers; tailor-made materials, having fun with grammar, and metacognition. In these ways the *Group Grammar Project* seems to have improved grammar knowledge and confidence for most students.

It would seem that the increase in the amount of work done at the ‘meta-reflective’ level improved the students’ ability for accurate self-assessment in grammar understanding. It could be argued that this in turn had enhanced their ‘preparedness’ to embrace the ontological shift necessary to cross the threshold. It could be argued that metareflection encouraged students to engage with their state of liminality towards the threshold identified in a positive and constructive way and helped with overcoming the paralysing ‘fear of grammar’ some had experienced at the beginning of the academic year.

Compared with the ease with which the majority of native French, German, Polish and Italian students, (who had been familiar with formal grammar teaching since primary school) tackled the analysis of the grammar categories, however, many negative attitudes towards grammar arising from the English school system proved difficult to ‘undo’. The European students did not perceive the grammar analysis of sentences in the assessed task as a ‘terrifying’ task like so many of their English counterparts. The author further concluded that the study had confirmed that a learning threshold of such complexity as the *rank scale concept* could not be adequately crossed in one year by many students.

ONTOLOGICAL TRANSFORMATIONS

The concluding section of this volume presents illustrations of the ontological transformations mentioned earlier in this chapter. These ‘learning thresholds’ might not be strictly conceptual, but seem necessarily occasioned by significant learning and are more concerned with shifts in identity and subjectivity, with procedural knowledge, or the ways of thinking and practising customary to a given disciplinary or professional community. An underlying implication here is that there is always some form of self-relational trajectory to the discipline being learned (Cousin 2009). We are a student and practiser of music in order to become a performing pianist. Being and knowing are inextricably linked. We are what we know, and we become what we learn. As Davies (2006) has pointed out, an act of learning is an act of identity formation.

In Chapter 18 **Jens Kabo** and **Caroline Baillie** examine one such ontological shift required by students of engineering when encountering engineering’s relationship with social justice. For much of their engineering education the students envisage their future development and practice as likely to comprise ‘problem solving, technical development, efficiency, and profit making’. This ‘common sense view’, the authors suggest, is likely to be predicated on an ‘inherent belief that technical development always equates to progress’. However such a perspective is now open to the challenge that rapidly accelerating technological advances and interventions are implicated in the rise of serious global challenges such as poverty and environmental sustainability (Catalano 2007). The production of biofuels, for example, though encouraged to counter global warming, has occasioned the unintended consequences of increases in food prices and the destruction of rainforests. The critical perspective of ‘who benefits and who pays’

hence becomes a necessary consideration in the reasoning and judgement of engineers. However, as these authors note, 'the established ways of thinking within a community or a group can serve as barriers toward new knowledge building, i.e. potentially create thresholds.' The 'thought collective' that the engineering students had entered, one of the authors found when teaching a course on social justice, seemed to constitute such a threshold. As students encountered the learning threshold of social justice they seemed to adopt the oscillative behaviour characteristic of liminal states. Students taking the course 'appeared to move into a liminal space, some passing through, some getting stuck and others moving back and forth uncertain of what to do.' For both experienced and novice engineers the required adoption of a socially just perspective to their practice and profession appeared to provoke a 'transformative and troublesome' state of liminality. The authors adapted the phenomenographic framework of Marton and Booth (1997) to assess variation in the response of learners to understanding and integrating the notion of social justice.

A key thing that varies over the different conceptions is the students' awareness of the complexities surrounding social justice, which goes from simple and superficial to complex and deep. Other shifts are from active to passive and individual to collective.

The outcome space achieved through this approach produced nine conceptions of social justice, ranging from a preliminal state of virtually no understanding, through a (liminal) moral awareness of social justice as duty and responsibility, to a more sophisticated recognition of social justice as a participatory undertaking, and on to a postliminal capacity to employ social justice 'as a lens for deconstruction and critical analysis'. The authors stress however that the nine conceptions are not to be seen as a linear progression 'since they both overlap and can exist simultaneously in how a student views social justice'. The barriers to understanding and progression were found to be often ontological, requiring a letting go of taken for granted collective cultural assumptions that engineering tends to be focused on money, profit making and efficiency rather than social justice. At the level of individual response, the learning threshold required 'sacrifice, risks, doubts and discomfort' and difficulty in moving 'beyond the things they took for granted'. As one student commented:

[The course] really messed with my head. Sometimes I was scared going to class because I didn't want to think about stuff. [...] it put some guilt on my actions [...] I feel that it might have an impact on my success in a company, for example if I don't do it the next person might.

In her work with colleagues on the Freshman Learning Project at Indiana University **Leah Shopkow** (Chapter 19) has encountered this kind of learning threshold, or as they term it, a conceptual 'bottleneck' or 'impasse' in understanding, across many disciplines. The difficulty may lie in "'basic" concepts, some of which may be threshold concepts, others of which may be clusters of threshold concepts, and some of which constitute disciplinary ways of knowing'.

In a separate but parallel project to the development of thresholds theory, but with a similar chronology, her colleagues have developed an approach to assist colleagues in ‘decoding’ their disciplines in order to become ‘more mindful teachers’ and hence more able to assist their students through these learning bottlenecks. She describes the work of Decoding the Disciplines (DtD) as follows:

DtD approaches the problem of impasses in student learning not from a theoretical perspective (although theory is quite useful in grounding its practices), but from a practical approach that emphasizes both the modelling of expert behaviour for students and the explicit explication of its underlying epistemes; the expert is rendered more self-conscious about these epistemes through a metacognitive dialogue between the expert and interviewers not necessarily within the expert’s discipline.

She suggests that the DtD methodology can facilitate the application of the theory of Threshold Concepts in five ways. First of these is that it can help ‘identify and order concepts and understandings ...where even the notion of essential concepts can be contested’. This often can apply in the Arts and Humanities, and History is examined here as a particular illustration. The range of learning thresholds identified within this discipline indicates how the conceptual and ontological are inextricably linked, and includes, to take a sample, developing and evaluating historical arguments, recreating historical context, maintaining emotional distance, overcoming affective roadblocks, willingness to wait for an answer, dealing with ambiguity, seeing artefacts from the past as representing choices that change over time, identifying with people in another time/place, understanding historical change, reading critically, writing historically, using appropriate language, and understanding notions of time. Secondly the author argues for the value of DtD in helping to surface tacit knowledge and render it more accessible. The latter she argues is a form of troublesome knowledge ‘both drawn upon and expected by the teacher’ and which students otherwise merely have to intuit. Her third point relates to the teacher’s own academic subjectivity in relation to pedagogy and the greater possibility of engaging discipline-focused academics in considering the difficulties in understanding faced by their students. ‘Because the methodology uses as its launching pad the instructor’s own disciplinary modes of thought and teaching concerns’, the author contends, it is less likely to be perceived as alien knowledge or foreign knowledge by the instructor’. This is in keeping with the point often made by Glynis Cousin that the thresholds approach invites disciplinary academics ‘to deconstruct their subject, rather than their educative practice, thus leaving them within both safe and interesting territory’ (Cousin, 2007; see also Flanagan, Taylor and Meyer, and also Weil and McGuigan, in this volume). A further and fourth point made by the author is that because the DtD approach helps clarify both the intended learning outcomes of the teacher and also where barriers to student understanding might lie, the process of course (re)design is made easier, as is also the means of evaluating whether students have achieved the intended

learning. This then, in turn, 'provides guidance for interventions'. Her final point raises the important issue of how learning thresholds might be addressed across the span of an entire curriculum lasting for several years. This requires a collaborative engagement at departmental or even institutional level.

No one faculty member is equally suited or has the kind of continuity of instruction with individuals to help students negotiate them all. If we want students not still to think like novices at the end of their undergraduate programs as they often still do (for a case in History, see Wineburg 2001), many faculty members will have to work collectively to this end. We will have to think about how Threshold Concepts might be sequenced in disciplines, like History, where the content is not sequenced of itself, so as to introduce students to these concepts in a systematic way, to ensure that students keep using the concepts to prevent student knowledge from becoming inert, and to help students learn to coordinate all the concepts that define the epistemes of the disciplines.

Sidney Weil and **Nicholas McGuigan** (Chapter 20) also take up the notion of epistemes, characterised by Perkins (2006, p. 42) as 'a system of ideas or way of understanding that allows us to establish knowledge. ... the importance of students understanding the structure of the disciplines they are studying. ... epistemes are manners of justifying, explaining, solving problems, conducting enquiries, and designing and validating various kinds of products or outcomes.' These authors examine the requisite learning structure for *bank reconciliations*, which is a single, traditionally difficult topic in Introductory Accounting, to determine whether such learning might be characterised as involving threshold concepts or perhaps is better explained through related notions of the episteme or what Lucas and Mladenovic (2006), in an earlier application of threshold theory to Introductory Accounting, have termed *threshold conceptions*.

The authors draw on an empirical study undertaken at the University of the Western Cape in which Accountancy students were questioned in the following manner:

- A. If the cash book has a debit balance of 810 Rand, what balance would you expect the bank statement to have?
- B. How and why, would you treat each of the following items when preparing a bank reconciliation statement?
 - (i) Bank charges on the bank statement.
 - (ii) Cheques made out in the cash book but not yet presented for payment to the bank.
 - (iii) A cheque from a debtor which has been deposited with the bank, but which is shown as dishonoured on the bank statement.
- C. The bank statement shows a debit balance of 410 Rand. There are unrepresented deposits of R465 Rand. How will you treat the unrepresented deposits in the bank reconciliation statement? What will the cash book balance be?

Such questions give rise to several important aspects of a bank reconciliation process. In A, the authors point out ‘students are required to visualize the relationship between a business’ cash records and the bank’s equivalent for the business. This relationship is a *mirror* image – equal in amount, but opposite in direction – either a debit or a credit’. In B students have to deal with certain unresolved items when preparing a bank reconciliation statement, which exposes the students’ understanding of the relationship between a bank statement and a cash book in greater depth, requiring them to be able to manipulate the cause and effect consequences of each situation. C also requires exercise of visualization skills in terms of how the unrepresented deposits might affect the respective bank and cash book balances.

The authors conducted a series of protocol analyses of the talk-aloud interviews with the Accountancy students. For this they drew on Feuerstein et al.’s ‘deficient cognitive operations’ model derived from the psychosocial theory of Mediated Learning Experience (MLE). This postulates that a lack of effective mediation results in deficient cognitive operations, for example, poor visualization of relationships and lack of inferential-hypothetical reasoning. According to Feuerstein et al. (1980, p. 71), such cognitive deficiencies help identify *prerequisites* of thinking, and refer to ‘deficiencies in those functions that underlie internalized, operational thought’. Analysis from the talk-aloud interviews revealed, amongst other phenomena, three forms of student difficulty in terms of *lack of inferential-hypothetical reasoning*, *narrowness of the mental field* and *poor visualisation of relationships*. These deficient cognitive operations overlap and also have an impact on the effective usage of data. In terms of the nature of the learning thresholds that these cognitive operations might constitute, the authors suggest that as they relate more to thinking skills or organizing structures than to concepts, they resemble more Lucas and Mladenovic’s (2006) definition of *threshold conceptions*, rather than concepts. Threshold conceptions are defined as ‘comprising an *organising structure* or *framework* which provides the explanatory rationale for accounting techniques’ (Lucas and Mladenovic, 2006, pp. 153–154). The authors identify similarities in this respect Perkins’ notion of the disciplinary episteme mentioned earlier. Interestingly they also point out the likely necessity of an ontological shift in overcoming these deficient cognitive operations:

Furthermore, the cognitive operations identified in this chapter as being part of an organising structure for studying Introductory Accounting could be argued to represent an ontological shift in how the study of accounting is viewed. A focus on the thought processes underlying a topic area, such as bank reconciliations, rather than on the content itself, may be a spark to ignite a major shift in how student’s perceive – and ultimately study – the discipline of accounting.

In their empirical study of design education **Jane Osmond** and **Andrew Turner** (Chapter 21) note the relatively undertheorised nature of this field, observing that ‘most research into design has focused on the *process* of design at the expense of the development of the designer’. They applied the threshold concept framework as

a lens or 'way in' to research the specific context of Transport and Product Design Courses and to open up a research dialogue with both students and staff on the courses. Initial explorations with staff as to whether 'spatial awareness' might be a threshold concept in Transport and Product Design revealed no common definition and responses ranging from 'all round awareness' to 'design sensitivity'. Student responses, gathered through a combination of qualitative interviews and questionnaires revealed states of 'having no knowledge', 'little knowledge' or 'guessing'. Though the notion of spatial awareness was not pursued further, and seen rather as a 'design capability', the response data had nonetheless provided valuable leads to other candidate thresholds. The notion of 'visual creativity' emerged as a necessary attribute for successful design graduates but integral to this seemed to be an ontological capacity for what the authors term the 'confidence to challenge', and this seemed to operate as a learning threshold. One tutor characterises this as 'the ability to inculcate design conventions and expand upon them using information from a variety of sources and experiences'. It seems a prerequisite to enable designers to tackle what Buchanan (1992) has termed 'wicked problems', that is, those having 'incomplete, contradictory, and changing requirements; and solutions to them are often difficult to recognize as such because of complex interdependencies.' Without this shift in subjectivity, design students, the authors report, 'can remain in a liminal state, constantly "surfacing around" in search of a solution'. Interestingly this threshold seemed to present even more difficulties to those international students used to a more prescribed style of teaching and curriculum:

I think during the very beginning I really struggled to really know what I should do in my projects - you really spend a lot of time to think about it but the result is not really that good as you expected because you keep surfacing around, you can't really make decisions about doing ... that's one of the most negative feelings because you don't know what to do sometimes - I mean I understand you do projects it is not really satisfying teachers, you learn during the process, but still you want to know what they really want. (First year international student)

The authors draw on the design process literature to gain helpful insights into what the nature of this liminal state might entail, drawing on notions such as Tovey's (1984) 'incubation period' during which 'the two halves of the brain are out of touch or unable to agree', or the idea of 'oscillation' between problem and solution. They cite Archer's view (1979, cited in Cross 1992, p. 5) that:

The design activity is commutative, the designer's attention oscillating between the emerging requirement ideas and the developing provision ideas, as he illuminates obscurity on both sides and reduces misfit between them.

They also draw on Wallace's (1992, p. 81) representation of this transformational state as 'problem bubbles' involving the solution of countless individual problems, like myriad bubbles within a larger bubble, and in which for the particular design

brief to be successfully achieved ‘the complete set of problem bubbles associated with the task must be solved; but many, many bubbles not directly related to the task will be entered between starting and finishing the task’.

In order to achieve the confidence to challenge, however, an intervening learning threshold was identified by the authors, namely the need to develop *a tolerance of being in a period of uncertainty*. Significantly, the authors observe, it is only after mastering toleration of this period of uncertainty that the students gain the ‘confidence to challenge’ and are then ready, or able, to tackle their design briefs which characteristically include the ‘wicked problems’ discussed earlier. This mastering of the toleration of uncertainty also clearly possesses an ontological dimension and entails a shift in subjectivity. The ‘holding environment’, or support structures that seemed to enable this shift are identified by the authors as including the ‘inculcating skills, capabilities and coping strategies delivered via an apprentice-like immersive method of teaching underpinned by an atelier, or studio-based, environment’. The staff respondents also identified important *transition points*, key moments during the course that moved the students on through the liminal state, and which included ‘first year assessments, the use of clay in the second year, exposure to the professional community of practice during the third year, coupled with the ability to work in groups and the development of empathy’.

In an interesting migration of threshold theory to the secondary sector of education **Ming Fai Pang** and **Jan Meyer** (Chapter 22) investigated dimensions of sub- and preliminal variation in secondary school pupils’ initial apprehension, via a range of ‘proxies’, of the threshold concept of ‘opportunity cost’. In this case the proxies were short scenarios designed to reveal variation in pupils’ understanding of ‘opportunity cost’. The following is an example:

Ben woke up at eleven and he planned to study for his exam in the afternoon. At noon, the phone rang. His girlfriend asked him to go to a movie. He decided to spend 4 hours in the afternoon with her. a. What choice did Ben make? Why did Ben have to make choice? What was the cost for Ben to go to see the movie? b. If the movie was boring, would it have increases his cost of going to the movie? Why or why not?

Forty Secondary 3 pupils of in Hong Kong took part in the study. They were following the ‘New Senior Secondary (NSS) Curriculum – Proposed Economics Subject Framework for Secondary 4–6 pupils in Hong Kong’, aimed at developing pupils’ interest in exploring human behaviour and social issues through a good mastery of fundamental economic themes such as ‘economic decisions involving choices among alternatives’ and the ‘concept of cost in Economics’. The pupils were of both sexes, had not previously taken economics as a school subject and came from schools of different levels of academic attainment and in different physical locations in the city. Interviews were held in Cantonese.

The inquiry drew on Marton and Booth’s (1997) ‘variation theory’ which posits that ‘pupils’ variation in the understanding of a disciplinary concept or practice, or alternative conceptions of the concept, hinges on those critical features of the concept or practice that pupils are able to *discern and focus on simultaneously*’.

Hence learning is seen as a capacity to discern and focus on the critical aspects of a concept or practice. In this case the threshold concept of opportunity cost became the object of learning whose critical features would need to be discerned and understood. The study also sought to measure variation in the extent to which pupils demonstrated evidence of a subliminal or preliminal state of understanding. The former relates to the learner's awareness and understanding of an underlying game or episteme – a 'way of knowing' – which may be a crucial determinant of progression (epistemological or ontological) within a conceptual domain. The latter concerns how a threshold concept initially 'comes into view' (i.e. is initially perceived or apprehended), and the mindset with which it might be approached or withdrawn from. According to the authors, those experienced in the manners of reasoning and justifying customary to economics are likely, in reaching a rational decision, to take into account both benefits and costs. Significantly 'they focus on both the option chosen as well as the highest-valued option forgone at the same time'. This was not the case with the Secondary 3 pupils however:

most of the pupils interviewed seem only to have some innate grasp of the allocation of preference or benefit part, and they thus focus only on the option chosen, taking for granted or ignoring the sacrifice or cost involved in choice making. Even though some pupils may have a sense of cost, what they focus on is the monetary cost involved in getting the chosen option, rather than the opportunity cost of getting the chosen option.

At one extreme, pupils failed to understand questioning related to the notions of 'choice' and 'opportunity cost' and could not demonstrate coherent ways of reasoning. At the other extreme a few were:

conscious of an embedded, consistent way of rationalising the phenomenon, although without the language to formalise it. They have developed an implicit way of using the concept of 'opportunity cost' to make sense of the world through the scenarios and they seemed to be 'thinking like an economist' without being aware of it.

For these few pupils some notion of choice or opportunity cost seemed to have come into view, suggesting the possibility of their already having reached a preliminal stage. Still others frequently *changed their minds* whilst discussing the same scenario, indicating perhaps oscillation between sub- and preliminal modes of variation, or between an economic way of understanding and a lay person's way of understanding. Occasionally students demonstrated an intuitive and quite sophisticated, economic way of reasoning.

In seeking to establish a 'transformative pedagogy' the authors propose targeting the *transformation of pupils' ways of thinking and reasoning*. This requires a prior ascertaining of pupils' original, intuitive and normal 'ways of knowing' and an understanding on the part of their teachers of the variation in 'how pupils initially perceive, apprehend, conceptualise or experience the threshold concept in the absence of any formalised knowledge of the concept itself'. This crucial

knowledge will, in turn, the authors argue, ‘inform an understanding of where *and why* pupils may find themselves in “stuck places” on their learning trajectory’. It also helps identify the *critical features* of pupils’ initial different ways of apprehending phenomena that act as proxies for threshold concepts, and these may involve both cognitive and ontological shifts. This then can open up the possibility, in both secondary and higher education, of genuinely transformative learning designs that can aid learners in their transition from naive or intuitive understandings of economic phenomena to the more sophisticated ways of reasoning and practising normal to the community of practice.

A further interesting migration of threshold theory, in this case from education to social science, and an equally interesting ontological shift, can be found in **Dagmar Kutsar** and **Anita Kärner**’s exploration, from a threshold concepts perspective, of societal transitions in post-communist Estonia (Chapter 23). Their aim is not only to ‘broaden the explanatory potential of the threshold concepts perspective of teaching and learning to examine societal transition processes in society’ but also ‘to develop a cognitive learning exercise from the experiences of students seeking new explanations, visions, and meanings of “the known”’. This involves applying the lens of threshold theory to an entire society at a critical point of political, social and economic transformation in the aftermath of the break-up of the Soviet state, with one political system having collapsed and being exchanged by another. In doing this society is examined as a learning and teaching environment in itself. ‘The transitions are meaningful events’, the authors observe, ‘accompanied by uncertainties, learning the new and changing identities and structures’. During this period of social transformation, society is ‘overwhelmed by a liminal space – no longer what it was and not yet what it will be. The liminal space is shared by the actors of transition, the institutions, groups and individuals all filled with a mixture of new and old cognitions, emotions, myths and behavioural patterns’. As was pointed out at the beginning of this section, an act of learning is an act of identity formation, but, as these authors emphasise:

Learning in rapid societal changes does not have a clear curriculum and all those involved are students. Meeting uncertainties and the ‘unknown’ leads to new perceptions and (‘troublesome’) knowledge... Examining rapid societal transitions in a particular country from the threshold concepts perspective, feels like putting the social learning process under a magnifying-glass.

The authors draw on Turner’s anthropological notion of liminality, as does threshold theory itself. In their view the entire population of Estonia entered a liminal state at the time of the (peaceful) Singing Revolution. This was the historical moment, in Turnerian terms, of leaving the old and meeting the new, and when the population, the social actors, enter a liminal state of what Turner called a *no-longer-not-yet-status*. The majority of these social actors, in the authors’ analysis, emerged into a postliminal state of order at some point in the mid 1990s, with new (and stable) social and economic structures. But this did not apply to all sectors of Estonian society. Continuing the Turnerian analysis, the authors describe the formation of

the *Communitas*, with its strong sense of togetherness, group experience and collective goals. This was very much occasioned by large musical gatherings or events such as The Baltic Chain peaceful protest held on the 23 August 1989:

The *Communitas* of Estonia, Latvia and Lithuania joined together in a human chain, hand-in-hand, from Tallinn, through Riga to Vilnius as a symbol of the shared destiny of the Baltic countries and the expression of the common goals of regaining their independent statehood. Approximately 2,000,000 people joined their hands over the 600 kilometre route to show that the Baltic people had united and shared their visions of the future. During this ritual, a mantra '*Estonia/Latvia/Lithuania belongs to us*' was echoed from person to person the length of the entire human chain.

As in other studies of learning thresholds, the liminal phase was found here to be a troubling experience, not always characterised by positive emotion. The authors speak of 'emotional tensions and fears of loss of cognitive control over the situation, which results in feelings of powerlessness, dissatisfaction and alienation', attributing this to the fact that well-being acknowledges the *possibilities* but also *limitations* for action. A survey of social stress at the time revealed high levels of social distress, 'anxiety, discomfort, different kinds of fears', particularly amongst male, non-Estonian, and older members of society. As this initial period of intense transformation, and transformational learning concluded, the social actors ventured into new and often strange spaces. New social, economic and political structures emerged (popular front, heritage society, green movement, creative unions, the Congress of Estonia) and new actors joined them in these spaces, such as exiles returning from the West and newly released former Soviet dissidents. We see variation entering into the experience of participants here, and also in terms of their role and changed status in the new social space.

Interestingly, young people who had had a '*missing experience*', no participatory experience in the Soviet system, were popularly viewed to have more worth in facing the challenges inherent in rebuilding the nation than those, like the nomenklatura, whose experience was deemed an '*invalid experience*'.

What seems to become manifest here is that whilst certain social actors, as social 'learners', successfully negotiate this phase of transformation and emerge into a transformed postliminal state, in both senses of that term, others – *The Others*, as the authors characterise them – remain in a liminal mode of oscillation. The non-Estonian (mainly Russian-speaking) population, we are told, 'needed more time for self re-identification and for re-positioning in the transition from being accepted as the dominant ethnic group and the speakers of the former state language (Russian) to being labelled as the ethnic minority with either weak or zero command of the state language (Estonian)'. Meanwhile the formerly powerful Soviet *nomenklatura* could be seen as remaining in a preliminal state, refusing to join the *Communitas*, seeking to maintain the old identities, and spreading social tension to prevent the new structures from taking hold. In keeping with the threshold theory notion of a holding environment, social myth emerged as a coping strategy for surviving the liminal state, even though the myths later 'disintegrated' in the postliminal state.

Social myths can be interpreted as threshold myths (Atherton et al., 2008), the functional value of which exceeds their value of being true. They are ideological beliefs with strong affective and political elements, which according to Atherton et al., (2008) serve as threshold concepts.

In the concluding chapter of this volume **Margaret Kiley** and **Gina Wisker** (Chapter 24), in a welcome application of threshold theory to postgraduate study, turn the lens of threshold theory to the field of research. In a survey of experienced supervisors in a range of different countries their concern is to identify ‘conceptual challenges that candidates encountered when learning to be a researcher, how supervisors recognised that a candidate had successfully met those challenges, and how they might have assisted the candidate in that process’. The purpose of the study was to attempt to identify ‘moments of research learning’ or ‘learning leaps’ in the experience of research students, to enable supervisors to develop effective strategies to better assist them in the kinds of conceptual threshold crossing that research undertakings involve.

Their enquiry drew on earlier influential studies such as the Reflections on Learning Inventory (RoLI) (Meyer & Boulton-Lewis, 1997). This was used to inform an action research programme with a large international UK PhD programme to identify when students can be seen, or not, to develop their approaches to, and perceptions of, the learning necessary at doctoral level. This pointed to factors such as identification of research questions, methodology and literature review as well as conceptual levels of enquiry, research design, data management, interpretation of findings and conclusions. The Students’ Conceptions of Research inventory (SCoRI) was next consulted. This had aimed to identify what research students and their supervisors envisaged as the nature and purpose of research. Research into the nature of the viva and doctoral examination was then explored to gain insights into the capacity of doctoral candidates ‘to present their work conceptually and to theorise and abstract their findings in ways which allowed them to have broader application’.

The convergence of these earlier dimensions of the authors’ work – namely student meta-cognition, conceptual level thinking and research students’ developing capacity to articulate and theorise their research learning – with the theory of threshold concepts became a catalytic point in their research. These earlier dimensions were seen as ‘crucial in the development of postgraduates’ doctoral learning journeys through to the crossing of conceptual thresholds and the achievement of their doctorate’. This convergence provided an initial focus to explore the conceptual crossings that students might encounter in the doctoral journey. Six candidate thresholds emerged from research data with staff and students: a) the concept of *argument* or thesis a concept which the research on doctoral examination frequently cites either because of its presence, or lack of it, in the dissertation; b) the concept of *theory* either underpinning research or being an outcome of research; c) *framework* as a means of locating or bounding the research; d) concepts of originality and *knowledge creation*; e) *analysis* (often criticised by examiners as too ‘haphazard’ or ‘undisciplined’); and *research paradigm*, that is ‘the epistemological framing of one’s approach to research’.

Building on these earlier findings the specific aims of the researchers then became the identification of:

1. How research supervisors recognise the acquisition of the threshold concepts
2. Where and how they recognise evidence they are crossing, and
3. How they 'nudge' candidates in the crossing of this threshold.

By 'nudging' the authors are referring to 'the constructive intervention of the supervisor to aid the student's conceptualised work'. This nudging takes place through 'staged interventions' during the development of the supervisory relationship at various stages of doctoral candidature. The following were recognised as particularly significant:

- The development of research questions.
- The movement from other-directed reading to self-directed and 'owned' reading of the literature leading to the development of a sound literary review.
- Working with data at different conceptual levels, analysing, interpreting and defining findings which make a contribution to understanding as well as factual knowledge.
- Developing an argument or thesis which can be sustained and supported.
- Producing the abstract and the conceptual conclusions.

These interventions were found to be key moments for helping candidates make 'learning leaps' and articulate their understanding at a conceptual level. Supervisors also identified specific elements in their supervision practices which seemed to assist their supervisees in the process of what the authors term 'conceptual threshold crossing'. These specific practices include the following:

- Encouraging engagement with the research question.
- Offering and prompting opportunities for engagement with the literature in relation to themes, issues and then in a dialogue with the candidate's own work.
- Oral prompting of conceptual work in groups, supervisory meetings, and individually.
- Encouraging conceptual and critical work with prompt feedback.
- Pointing out contradictions and tensions.
- Encouraging careful data analysis, developing themes, engaging with theories.
- Encouraging early writing and much editing-sharing and reflection.
- Using the language of 'doctorateness' e.g. conceptual framework, and the ideas, the research and theories of learning e.g. meta-cognition.
- Offering opportunities to articulate ideas and achievements in mock *vivas* and other oral presentations.

The authors contend that evidence of a candidate's behaviour changes is often a proxy indication that the student has crossed a particular conceptual threshold and that this indicates a change in subjectivity, a 'shift, a change, in the learner's appreciation and understanding of her/himself as well as what has been learned'. Though these ontological shifts often incur challenge and a degree of troublesomeness, they generally were found to occasion new insights and access to new levels.

Students are perceived to be changing their ways of working, their contribution to meaning, and also changing in terms of behaviour, particularly their ways of going about their learning. Identity is then an important factor noted by supervisors in terms of the changing ways students engage with, conduct and articulate their research.

CONCLUSION

We hope that the chapters that follow in this book convey something of the vibrancy and engagement that characterised the conference in Ontario where they were first presented and discussed. It is encouraging to see the widespread adoption of the thresholds framework across many disciplines, institutions and countries, and its migration into new sectors and fields. Our thanks are due to the many writers included in this volume, and to the generosity of their colleagues and students in contributing their time, thoughts and feelings in discussion and dialogue about learning thresholds and troublesome knowledge in a common endeavour to gain better insights into student learning and conceptual difficulty. As we go to press with this volume plans are already well under way for a third international conference on thresholds to be held in Sydney in July 2010, jointly hosted by the Universities of Sydney and New South Wales. We look forward with great anticipation to further engagement around this continually intriguing theme, to renewing discussions with old friends and embarking on future explorations with new ones.

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FOREWORD

Entrance...and entrance. Am I repeating myself? Not if you listen really hard. The first 'entrance' has the accent on the initial syllable and the second on the ultimate – EN-trance and en-TRANCE. Such pairs are called heteronyms, same spelling, different pronunciation. Both words trace their ancestry back to the Latin *transire*, to go across, albeit by quite different routes. And both words apply quite well to the notion of threshold concepts, launched through seminal articles by Ray Land, Jan Meyer and their colleagues a few years ago and explored and extended here, as well as in two previous volumes (Land et al 2005, Land, Meyer and Smith 2008, Meyer and Land 2003, 2005, 2006, 2009, Meyer, Land and Davies, 2008).

Meaning 1: EN-trance. When learners acquire a threshold concept, they enter into a new realm of understanding. Quick examples include the concepts of 'limit' in mathematics, 'gravity' in physics, 'depreciation' in accounting, and 'deconstruction' in literature. Innumerable other instances populate the chapters of this volume. Many of these transformative ideas are not concepts in any strict sense but varied ways of thinking and practicing with a threshold-like nature, all of them affording entrance in one sense or another.

Meaning 2: en-TRANCE. This volume and its predecessors give ample evidence that threshold concepts entrance -- they entrance scholars and teachers concerned with the nature and challenges of learning in the disciplines. Discourse around threshold concepts has proven to offer something of a common language, provoke reflection on the structure of disciplinary knowledge, and inspire investigations of learners' typical hangups and ways to help. Indeed, it's been my pleasure to add to this conversation from time to time on the theme of *troublesome knowledge*, the characteristic ways in which learning poses challenges (e.g. tacit knowledge, conceptually difficult knowledge, ritual knowledge) and the value of constructing "theories of difficulty" for the disciplines that chart where the cracks and chasms of learning lie and suggest ways of bridging them.

So why the entrenchment? What is it that so many educators have found alluring about threshold concepts? One answer touched on in the upcoming introduction was suggested by Glynis Cousin (2007) a couple of years ago – threshold concepts invite instructors to examine their disciplines rather than looking directly at their teaching practice, both a more comfortable and a more interesting journey for many.

Another related reason seems to be the very fecundity of threshold concepts, the evolutionary proclivity of the idea toward adventurous and fruitful mutation. As an occasional participant in these conversations, I am always struck by how productively imprecise the notion is.

Put the matter this way – Is ‘threshold concept’ itself an *ideal* threshold concept? For sure, it has brought many scholars to a new view of things. But a truly prototypical threshold concept perfectly fills a critical slot in a mature home discipline, as with the cases mentioned above. Novices may get confused and confounded, but not experts.

In contrast, ‘threshold concept’ itself seems to have the heart of a nomad. In the chapters to come, it gets stretched, challenged, revised, reconsidered. Back to the evolutionary metaphor, consider today’s biological concept of a bird, precisely demarcated by features such as feathers, toothless beak, hard shelled eggs, four chambered heart, etc. All very neat! Now imagine a biologist roaming around in the Jurassic, 150 to 200 million years ago. “Is this a bird?” the biologist asks. – “But it has teeth!” “Is that a bird? -- But those aren’t really feathers!” The diversity was startling and the boundaries not yet formed when small theropod dinosaurs fluttered across the threshold of flight into the new world of the air. Moreover, contemporary paleontology suggests that many of the features that today we take as distinctive of birds developed *before* flight...including feathers.

The flock of ideas around threshold concepts seems to me more analogous to the bird-like-creatures of yesteryear than to *Aves* of today, more exploratory and eclectic than categorical and taxonomic. All to the good! -- the richness of this volume testifies to that. So welcome to Jurassic Park! Here we are at the EN-trance. Prepare to be en-TRANCED.

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**PART I:
EXTENDING THE THEORY**

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1. CHANGING OUR MINDS

The Developmental Potential of Threshold Concepts

INTRODUCTION

In writing this chapter, I have to come to a startling personal revelation: I am a philosopher, if only an amateur one. Perhaps this revelation should not be so startling, for I have always been a lover (*philo*) of wisdom (*sophia*). And I am, after all, in the process of completing a doctor of philosophy degree.

At the heart of a philosopher's approach lies the activity of asking questions. Gaarder (1994) explains, however, that philosophers are generally not captivated by the entire realm of philosophical questions, yet have particular queries with which they are especially concerned. Therefore, philosophers' questions provide valuable insight into their philosophical *projects*.

What, then, is my philosophical project? Broadly, in my work, I am intrigued by questions about learning in higher education. At the beginning of each project, I therefore return to the question 'What is learning?' for I realise that my interpretation lies at the heart of all subsequent thinking. Here, I adopt the perspective that *learning is an active process of meaning-making* (e.g., Anderson and Krathwohl, 2001; Belenky, Clinchy, Golberger, and Tarule, 1986/1997; Kegan, 1982; Perry, 1970). The question that follows, then, is 'How does learning happen?' Indeed, learning is often characterised as a developmental process. In his Constructive-Developmental Theory of Meaning-Making, Robert Kegan (1982) elegantly weaves together the notions of meaning-making and development, and posits that individuals' abilities to construct meaning evolve through regular periods of stability and change throughout their lifespan.

It is these periods of change, these transitions that characterise the learning process, which I find most intriguing. These transitions remain nebulous; however, understanding them is crucial. Cross (1999) notes that 'in developmental theory, the periods of greatest personal growth are thought to lie in the unnamed and poorly-defined periods *between stages*' (p. 262; emphasis in original). We might therefore imagine that the most significant aspect of learning lies not in the *outcomes* of learning, but in the *process* of learning. Understanding this process and how best to facilitate it is thus essential to our work as educators.

How fortunate, then, that we may now turn to the growing body of literature on threshold concepts for, in their identification of threshold concepts, Meyer and Land (2003) appear to have captured the inherently developmental nature of these

trajectories of learning. Indeed, Perkins (2007) notes that threshold concepts are ‘especially pivotal to a stage-like advance in understanding a discipline’ (p. 36). The focus of my current project is therefore to examine issues central to threshold concepts, such as ‘liminality,’ and to explore the characteristics used to describe threshold concepts, such as ‘troublesome,’ ‘transformative,’ ‘irreversible,’ ‘integrative,’ and ‘bounded’ in light of developmental principles in order to help us better understand the complex nature of the learning process.

In exploring the characteristics of threshold concepts from a developmental perspective, we begin to capture a sense of the work that threshold concepts are doing: they are transforming, integrating, making trouble, but of what? Thus, the question remains as to *what* is changing and allowing us to remark that a threshold has been crossed, that a transformation has occurred, that a learner has moved from one stage, one way of making meaning to the next?

Indeed, what we are witnessing, experiencing, or contributing to is the transformation of the *essence* of a particular position or stage from which meaning of the world is constructed. Kegan (1982) theorises that at the heart of a stage of meaning-making is a way of knowing, an epistemology, which shapes the ‘window or a lens through which one looks at the world’ (Kegan, with Debold, 2002, p. 3). While we will return to the question of essence later, here, I wish to emphasise that the great value of threshold concepts is that they serve to instigate a process of ‘epistemological transitions’ (Meyer and Land, 2005, p. 386); that is, transitions not only in *what* learners know, but in *how* they know; transitions that may provide a ‘transformed internal view of subject matter, subject landscape, or even world view’ (Meyer and Land, 2003, p. 1). This chapter is therefore an attempt to capture and qualify the transitional process instigated by threshold concepts and explore its potential influence on our practice as educators.

UNDERLYING ASSUMPTIONS

Many questions remain to be investigated in our exploration of the developmental nature of threshold concepts, questions such as ‘How might a developmental perspective be used to explain variation in learners’ responses to threshold concepts?’, ‘What is the relationship between learning and development?’, and ‘How might troublesomeness be developmentally productive?’. I would now like to comment briefly on the approach I will take to answering these questions.

One of my fundamental assumptions is that questions are best approached from what I qualify as an *integrationist* approach. As people trained or training to become disciplinary experts, we may so easily become mired in our own contexts that we may fail to consider that the questions about which we feel so passionate are the same questions that intrigue our colleagues in other fields. The question of thresholds and the processes and mechanisms which drive development towards and across thresholds are not only questions of educational psychology (my own field), but also those of the fields in which educational psychology is rooted: philosophy, biology, and psychology. Consequently, in my attempt to situate the characteristics of threshold concepts within a developmental framework, I draw on

Kegan's (1982) interdisciplinary Constructive-Developmental Theory, as well as on work in these other fields, searching for the deeper principles of development that at once underlie, transcend, and thereby unify our specific contextual concerns.

In my exploration, I will also attempt to capture the *simultaneously cognitive and affective* nature of these epistemological transformations. While cognitive processes are often emphasised in accounts of learning, the affective nature of these transitions is often minimised, denigrated, or altogether ignored. Consequently, the appeal of Kegan's Constructive-Developmental Theory (1982) is its acknowledgement of 'the equal dignity' (p. 107) of cognition and affect. It is a theory that recognises that 'we are [evolutionary] activity and we experience it' (pp. 81–82). As we will see later, this conceptualisation has deep implications for the ways in which we view the process of epistemological transformation triggered by threshold concepts.

Thank you for reading. Now let us begin addressing some of our questions.

PRELIMINAL VARIATION, OR, ON BALANCE

A powerful image that Kegan (1982) uses to guide our understanding of the evolution of stages or 'orders' of meaning-making is that of *balance*. Two intriguing questions now emerge: 'How might the notion of balance contribute to our understanding of the learning process?' and 'Might the notion of balance help us account for variation in learners' responses to the process of transformation instigated by threshold concepts?'

The language of balance permeates our daily lives: we are concerned with maintaining balance in the world's ecosystems, balancing our diets, and finding work-life balance. This concern may be traced to ancient times, where cultural myths reveal that people sought ways to preserve the balance between 'the forces of good and evil' (Gaarder, 1994, p. 25). Hippocrates believed that 'when sickness occurs, it is a sign that Nature has gone off course because of physical or mental imbalance' and that "that the road to health for everyone is through moderation, harmony, and a 'sound mind in a sound body'" (Gaarder, 1994, p. 56). With respect to our cognitive development, Piaget proposes equilibration as a process through which balance is sought by integrating interactions between the organism and the environment (Ferrari, Pinard and Runions, 2001; Piaget, 1950).

What we are balancing, in fact, is *essence*. The question of essence also concerned the earliest Greek philosophers. Gaarder (1994) explains that there existed a shared belief that 'nothing comes from nothing' (p. 41). Parmenides, for example "had refused to accept the idea of change in any form. [...] His intelligence could not accept that 'something' could suddenly transform itself into 'something completely different'" (p. 41). This, then, was the 'problem of change,' the question of 'How could one substance suddenly change into something else?' (Gaarder, 1994, p. 35).

The assumption, therefore, was that "'something' had always existed" (Gaarder, 1994, p. 33). And by examining the notion of essence, we address the question of precisely what is emerging and being organised into qualitatively different (e.g. Kegan, 1982; Lewis, 2000; Schunk, 2000) and more complex forms.

In an edited volume entitled ‘Reframing the Conceptual Change Approach in Learning and Instruction,’ Baltas (2007) examines the notion of an essential ‘something’ changing in conceptual change. He states that

the fact that [...] ‘something’ remains invariant is faithfully reflected in the pertinent ‘Eureka!’ experience, for this is an experience that cannot engage but a single thing at both its ends: after having undergone it, we understand exactly what we were incapable of understanding before. (p. 66)

Baltas (2007) suggests that what we were incapable of understanding before were our background ‘assumptions’ (in quotation marks). These background ‘assumptions’, which ‘were formlessly taken along as a matter of course and to which, accordingly, questions could not be addressed,’ once disclosed, become assumptions (without quotation marks), that is, ‘proposition[s] that can be doubted and thence conceptually and experimentally examined [...] becom[ing] open to rejection, revision, justification, and so forth’ (p. 66).

The notion of balance suggests that there must be more than one component to essence, and that some kind of tension must be resolved between opposites in order to obtain balance. And there is strong evidence in the philosophical, biological, and psychological literatures that supports the existence of opposites in our ideas, physiologies, and psyches. Saussure posits that ‘binary opposites’ characterise the structure of philosophical discourse; ‘Anthropologist Claude Lévi-Strauss maintained that a system of binary codes operates in all cultures as their common logic’ (Robinson and Groves, 2004, p. 160). Derrida’s deconstructive approach to reading philosophical texts suggests the existence of ‘multiple meanings at war with each other in the texts’ (Robinson and Groves, 2004, p. 162). Biologists speak of ‘evolution and its periods of adaptation – of life organisation – as involving a balance between differentiation and adaptation’ (Kegan, 1982, p. 107).

In psychology, Erikson (1959) writes of the various shifts in balances between intimacy and isolation as individuals progress through young adulthood. Jung (1959) posits that our psyches are made up of numerous opposing spheres which we attempt to unite. He powerfully describes a pair of opposites as being ‘one of the most fruitful sources of psychic energy’ (p. 82). In their theories, Erikson and Jung also succeed in capturing how fundamentally unsettled we feel when our balance is threatened or disturbed. The resulting ‘crises’ (Erikson, 1959) and ‘disequilibrium’ (Jung, 1959) may be so powerful that they may lead to a feeling of ‘being torn apart’ (Magen, Austrian, and Hughes, 2002, p. 187).

Resulting from this process of interaction among opposites is not a static equilibrium, but what philosophers, biologists, and psychologists refer to as a *dynamic equilibrium* (e.g. Homeostatis, 2007; Kegan, 1982; Wood, 1998). This process of interaction among opposites continues throughout the ongoing course of development, and each stage consequently represents a qualitatively different and temporary ‘evolutionary truce’ (Kegan, 1982).

Kegan describes each truce as the coordination of the two essential elements of epistemology: what we view as ‘subject’ and what we view as ‘object’:

What I mean by ‘object’ are those aspects of our experience that are apparent to us and can be looked at, related to, reflected upon, engaged, controlled, and connected to something else. We can be *objective* about these things, in that we don’t see them as ‘me.’ But other aspects of our experience we are so identified with, embedded in, fused with, that we just experience them as ourselves. This is what we experience *subjectively* – the ‘subject’ half of the subject-object relationship. (With Debold, 2002, p. 3; emphasis in original)

Each new truce therefore discloses more of that in which we were embedded, thereby enabling us ‘to listen to what before [we] could only hear irritably, and [...] to hear irritably what before [we] could hear not at all’ (Kegan, 1982, p. 105).

As educators, we must be acutely aware that the construction of meaning, the journey to each new truce, is both a cognitive *and* a deeply emotional venture for learners. Atherton (2008) tellingly writes of the ‘cost’ of learning, describing ‘learning as loss’ – the loss of a certain way of thinking about and being in the world. Boyd and Myers (1988) speak of the four phases of ‘grief’ learners experience during a transformative learning process. William Perry (1981) also writes compellingly of the emotional upheavals involved in the developmental process:

I have remarked elsewhere (Perry, 1978) on the importance we have come to ascribe to a student’s ‘allowing for grief’ in the process of growth, especially in the rapid movement from the limitless potentials of youth to the particular realities of adulthood. Each of the upheavals of cognitive growth threatens the balance between vitality and depression, hope and despair. It may be a great joy to discover a new and more complex way of thinking and seeing; but yesterday one thought in simpler ways, and hope and aspiration were embedded in those ways. Now that those ways are left behind, must hope be abandoned too?

It appears that it takes a little time for the guts to catch up with such leaps of the mind. (p. 108)

And, indeed, in the following section, we will explore some of the reasons why it may take our emotions some time ‘to catch up with’ our minds, and why our minds may be resistant to change in the first place.

Preserving Balance

Inherent in the notion of dynamic equilibrium explored earlier is the idea of *preserving* balance. Indeed, within both human biological and psychological systems, there is a strong tendency to maintain a state of equilibrium, which amounts, in some ways, to *resisting* the ongoing motion of development. Within the biological process of homeostasis, there exist states of dynamic equilibrium in

which the system in balance ‘resists outside forces to change’ (Homeostasis, 2007). As Kegan expresses more colloquially, there is a strong tendency to keep things ‘pretty much as they are’ (with Debold, 2002, p. 5).

In keeping things as they are, the human (organism) is, in fact, stating, ‘I have boundaries that I do not want transgressed.’ From a biological perspective, boundaries provide a crucial ‘distinction between everything on the inside of a closed boundary and everything in the external world’ (Dennett, 1991, p. 174). Dennett (1991) explains that this distinction ‘is at the heart of all biological processes’ and provides the powerful example of the immune system, ‘with its millions of different antibodies arrayed in defense of the body against millions of different alien intruders. This army must solve the fundamental problem of recognition: telling one’s self (and one’s friends) from everything else’ (p. 174).

Human psychological systems are equally adamant in their struggle to prevent change. In his theory of cognitive dissonance, Festinger (1957) explains that individuals attempt to achieve and maintain *consistency*, or *consonance*, between their knowledge, opinions, beliefs, and actions. Piaget’s (1950) notion of assimilation captures the attempt to integrate experiences to existing cognitive structures. Perry (1970) notes that these assimilations ‘tend to be implicit’ (p. 42). That is, we tend to be unaware that they are occurring. Experiences are unconsciously integrated. Consequently, existing cognitive structures remain intact; the current perspective from which we view the world remains acceptable; balance is preserved.

Kegan (with Scharmer, 2000) remarks that these balances are very ‘hardy,’ (p. 11) particularly during adulthood. It becomes more and more difficult for experiences to undo this balance, to break through a boundary, to ‘win through [our] increasingly complex defenses that have better and better ways of deluding us into the belief that we have grasped reality as it actually is’ (Kegan, with Debold, 2002, p. 6). These balances are hardy because, ‘assimilation is defense, but defense is also integrity’ (Kegan, 1982, p. 41). The threat of change is a threat of *dis-integration*: the disintegration of a particular way of knowing that arises from the disclosure of one’s assumptions or from disentangling oneself from that in which one was embedded. And if, as we saw earlier, emotion is an integral part of the process of change, there may be great *fear* in losing a self with whom one is familiar (Atherton, 2008; Berger, 2004; Taylor, 1995). In the face of new learning, this fear may reveal itself as a ‘numbness,’ where the learner may appear to be ‘under an anesthetic’ and as though ‘suspended in time’ (Boyd and Myers, 1988, p. 278).

It is not only fear and desire to preserve balance that prevent change, however. At times, people may have ‘sincere, even passionate intentions to change’. Kegan explains that a recent medical study

concluded that doctors can tell heart patients that they will literally die if they do not change their ways, and still only about one in seven will be able to make the changes. These are not people who want to die. They want to live out their lives, fulfill their dreams, watch their grandchildren grow up – and, still, they cannot make the changes they need to in order to survive. (With Carroll, 2007, p. 1)

In fact, Kegan and Lahey (2001) have labelled this tendency to resist change, even when faced the prospect of death, *immunity to change*. Kegan (with Carroll, 2007) describes their work as

pay[ing] very close – and very respectful – attention to all those behaviors people engage in that work against their change goals [...]. Instead of regarding these behaviors as obstacles in need of elimination, we take them as unrecognized signals of other, usually unspoken, often unacknowledged, goals or motivations. (p. 1)

Kegan refers to these goals and motivations as ‘commitments,’ and suggests that they may provide educators with rich insight regarding learners’ unwillingness to change.

In our exploration of the notions of balance and preservation of balance, we have encountered several ideas that may help us account for why ‘mental development is so often steadfastly invariant, so resistant to inspired pedagogy, so limited in transfer’ (Bruner, 1997, p. 70). Indeed, learners’ fears of giving up a sense of integrated selfhood, as well as commitments, either explicit or implicit, may help explain why learners get ‘stuck’ (Meyer and Land, 2003) or resist learning, particularly learning of the kind implied by the notion of threshold concepts, that is, learning of an epistemological transformational kind. These ideas suggest that variation in responses to threshold concepts may be linked to learners’ readiness for change. That is, there may exist an ‘optimal’ or ‘open period’ during which a learner is most likely ‘to respond to stimulation’ (Kohlberg and Mayer, 1972, p. 490). Consequently, appropriately *timing* the introduction of threshold concepts might be an especially important consideration when designing learner-centred instruction.

TROUBLESOMENESS, OR, ON DISSONANCE

The discussion of variation in learners’ responses to threshold concepts leads us to consider the following questions: What is the link between learning and development? Must development precede learning? Are learning and development synonymous? Does learning stimulate development? Vygotsky (1978) reviews these different positions and advances that ‘the essential feature of learning is that it creates the zone of proximal development; that is, learning awakens a variety of internal developmental processes’ (p. 90).

A logical next question is thus, ‘What type of learning leads to development?’. While it is perhaps commonly believed that exposing learners to more and different types of experiences and information, or that ‘teaching harder’ (Perkins, 2007) will lead to development, the appropriate answer to this question may reveal a more qualitative than quantitative issue. Indeed exposure (even lots of exposure) does not guarantee that an organism will change in any significant way. In order for transformation to occur, learners must first perceive these experiences, knowledge, or phenomena to be ‘dissonant’ (Festinger, 1957), ‘disorienting’ (Mezirow, 2000), or what the literature on threshold concepts has come to qualify, ‘troublesome’ (Meyer and Land, 2003; Perkins, 1999).

Schunk (2000) remarks that ‘the dissonance notion is vague’ (p. 306). Work by Perkins, however, is doing much to elucidate this concept. His exploration of troublesome knowledge (Perkins, 2006) and theories of difficulty (Perkins, 2007), reveals a variety of reasons that may account for what makes certain sources of knowledge, including threshold concepts, particularly troublesome for learners. And, a deeper understanding of troublesomeness may reveal potentially powerful sources of transformation.

Both the biological and cognitive psychological literature suggest that, to promote development, phenomena must somehow be troublesome enough, inharmonious enough from existing structures, to disturb balance and lead the organism to actively respond (e.g., Festinger, 1957; Homeostasis, 2007). The purpose of this activity is to restore balance and, for humans, constitutes the very *making* of meaning.

Yet, with what actions do we respond to these instigators of change? To address this question, we must consider and acknowledge that, along with the cognitive experience of doubt, may come the emotional experience of self-doubt: the unsettling feeling that arises when one questions one’s ways of seeing, of being in, the world.

While ‘doubt is an uneasy and dissatisfied state from which we struggle to free ourselves and pass into the state of belief’ (Fisch, 1951, p. 59. In Murphy, 2003, p. 138), there is no guarantee that the state of belief will be a new one. It may, in fact be the already existing state of belief, as the tendency to preserve balance may still be strong at this time. That is, learners may choose to respond to epistemic doubt by ‘ignor[ing] their feelings [...] because they feel so strongly about their current beliefs’ (Bendixen and Rule, 2004, p. 75). Alternatively, they may experience a range of emotions, from ‘a painful pining or yearning for that which has been lost to protest over the present situation’ (Boyd and Myers, 1988, p. 278).

It is perhaps Perry (1981) who comments most eloquently on the ‘deflections from growth’ that might occur when learners become especially adamant in preserving balance even after the infiltration of doubt. He observes that being confronted with information and experiences revealing the inadequacy of their current belief system may not be sufficient to instigate growth in learners, and may, in fact, cause some to react with ‘apathy,’ ‘anxiety,’ ‘depression,’ and even educational ‘cynicism’ (p. 90). Learners may ‘temporize;’ that is, they may ‘simply wai[t], reassigning the agency for decision to some event that might turn up’ (p. 90). Alternatively, they may ‘retreat’ to a former position (p. 91). Finally, they might ‘escape.’ Perry (1981) claims that it is during this period of escape that ‘the self is lost through the very effort to hold onto it in the face of inexorable change in the world’s appearance’ (p. 92).

There are several implications of the above discussion on our interpretation of threshold concepts. First, if we accept that some degree of dissonance is often necessary to stimulate development, then the troublesome or ‘nettlesome’ (Sibbett and Thomson, 2008) nature of threshold concepts may be the very quality that reveals their developmental potential. Consequently, their power may be that they trigger dissonance not only at the cognitive and affective levels, but also dissonance

at the epistemological level, calling upon learners to ‘change their minds,’ not by supplanting *what* they know, but by transforming *how* they know. Furthermore, that learners respond to discrepancies in different ways, that is, by avoidance, assimilation, or, as we shall see, by accommodation (integration), suggests that there may exist highly individual reasons determining responses to threshold concepts, reasons such as alternative commitments and readiness for change. Finally, given the affective nature of these changes, our task as educators is to acknowledge the difficult journey on which we are asking students to embark. We may thus envision ways of foreshadowing for students the impending sense of loss and help them to live more comfortably with their discomfort.

TRANSFORMATIVENESS, OR, ON OPENING UP OF EPISTEMOLOGICAL, CONCEPTUAL, AND AFFECTIVE SPACES

Kegan (1982) notes that epistemic doubt may indeed lead one to ‘the limits of [one’s] ways of knowing the world’ (p. 59), and, as we have seen, this may cause some learners to temporarily arrest their epistemic development. Yet, is this the response of most learners? Perry (1981) remarks that it is not. The response to epistemic doubt caused by troublesomeness may also take the form of action towards change, action marking the beginning of the transformative process, action which may ‘open[...] up a new and previously inaccessible way of thinking about something’ (Meyer and Land, 2003, p. 1).

The idea of ‘opening up’ new ways of thinking is captured in the work of many researchers interested in learning. Baltas (2007) characterises the disclosure of background ‘assumptions’ in conceptual change as ‘widen[ing] up and modify[ing] [...] the [...] space available to inquiry’ (p. 65). In their exploration of professors’ developing conceptions of teaching, Entwistle and Walker (2002) characterise professors’ sophisticated, learning-centred conceptions of teaching as ‘lead[ing] to an expanded awareness – seeing additional goals for teaching and learning which were originally not perceived explicitly at all’ (p. 17). Kegan (1994) eloquently notes that

transforming our epistemologies, liberating ourselves from that in which we were embedded, making what was subject into object so that we can ‘have it’ rather than ‘be had’ by it – this is the most powerful way I know to conceptualize the growth of the mind. (p. 34)

We may therefore begin to envision that the transformative process involves not only the expansion of epistemological and conceptual spaces, but also, as Meyer and Land (2005, 2006) explain, the expansion and transformation of identity, of a learner’s ‘sense of self’ (2006, p. 19). We must also consider that this process of transformation, and hence movement within these liminal spaces, is not unidirectional, yet may ‘involve oscillation between stages, often with temporary regression to an earlier status’ (Meyer and Land, 2005, p. 376). Boyd and Myers (1988) speak of the ‘oscillating movement [...] from disorganization to despair’ (p. 278) that characterises this phase of grieving in the process of transformational

education. Berger (2004) characterises transformational spaces as ‘precarious’, and Kegan (with Scharmer, 2000) describes entering into a transitional space as feeling much ‘like going off a cliff’ (p. 11).

Yet, when standing on the edge of a cliff (or a threshold), might some learners feel terror, while others feel exhilaration? Stated otherwise, ‘Does this liminal space feel the same for everyone?’ In her thought piece entitled ‘Dancing on the Threshold of Meaning: Recognizing and Understanding the Growing Edge,’ Berger (2004) suggests that it might not. She recounts the stories of two women, Kathleen and Melody, both facing times of profound transition in their lives. Kathleen is ‘excited [...] and not knowing about her future leaves her filled with possibility and hope’ (p. 341). Melody, on the other hand is both ‘frighten[ed]’ and ‘unhappy’ (p. 342) in this space of transformation. Berger’s (2004) account of these two women, one who embraces the period of transition, and the other who retreats from it, provides evidence of a ‘complex continuum’ (p. 343) of emotional responses to the liminal space.

As we saw earlier, underlying this complex variation of individual responses may be issues of alternative commitments and readiness for change. What these issues may signal, in fact, is variation in learners’ current ways of making meaning. Perry’s seminal study entitled the ‘Intellectual and Ethical Development of College Students’ (1970) originated in an attempt to account for the variations he had observed in the ways in which college students were responding to the ‘the pluralistic intellectual and social environment of the university’ (Hofer and Pintrich, 1997, p. 90). What Perry ultimately showed was that different responses to external conditions could be attributed to individual differences in learners’ epistemic beliefs. That some learners ‘open up,’ while others clearly get ‘stuck’ (Meyer and Land, 2005, p. 380), may signal to us as educators that the epistemological transition being instigated by a threshold concept lies *beyond* the learner’s zone of proximal development (Vygotsky, 1978). That is, it lies too far beyond what the learner may achieve when guided by more skilful others. These variations in response to teaching caution us to be attuned to variations in the ways that learners are making meaning.

IRREVERSIBILITY, OR, ON CROSSING THRESHOLDS

Berger (2004) notes that “Bridges (1980) described as the hardest piece of transformation the ‘neutral zone’ when the past seems untenable and the future unidentifiable” (p. 343). That the past seems unreachable, suggests that there is a time in the transformation process when the individual crosses a threshold.

The Oxford dictionary defines that a threshold ‘symbolically [...] marks the boundary between a household and the outer world, and hence between belonging and not-belonging, and between safety and danger’ (Simpson and Roud, 2000) and consequently between the former world and the new world. In biology, a threshold indicates the minimum, yet critical level a stimulus must attain to ‘produce excitation of any structure’ (Therxold, 2000). Thus interpreted, the inherent troublesomeness of threshold concepts may provide the impulse that ‘excites’ an individual and leads to the type of action that carries him/her across a threshold towards epistemological transformation.

Might a learner revert to former ways of knowing after crossing a threshold? In characterising threshold concepts as ‘irreversible,’ Meyer and Land (2003) suggest ‘that the change of perspective occasioned by the learning of a threshold concept is unlikely to be forgotten, or will be unlearned only by considerable effort’ (p. 4). Baltas (2007) would call the impossibility of “forsaking the ‘Eureka!’ experience” and returning to previous ways of understanding an ‘irreversible achievement’ (p. 76). Thus, on a path of development from one way of knowing and meaning-making, one epistemic stage or stance to the next, there seems to exist a point in our journey when we cross a threshold and our old way of knowing is no longer ‘tenable’. There is an irreversible shift in the way in which ‘essence’ is coordinated. There emerges a new space from which to observe and analyse the world.

Accompanying the new, however, is a loss of the old: old ‘status,’ old ‘identity within the community’ (Meyer and Land, 2005, p. 376), old ways of knowing, seeing, and being in the world. As we saw earlier, these liminal spaces where one is ‘betwixt and between’ ways of knowing are understandably deeply emotional, sometimes ‘painful’ (Boyd and Myers, 1988, p. 277; Love and Guthrie, 1999, p. 72), sometimes exhilarating. They are spaces where ‘the individual is naked of self – neither fully in one category or another’ (Goethe, 2003. In Meyer and Land, 2005, p. 376). Yet, this state of liminality does not as yet represent the new developmental stage, for, as Kegan (1982) reminds us, ‘development is not a matter of differentiation alone, but of differentiation *and* integration’ (p. 67; emphasis in original).

THE INTEGRATIVE NATURE OF THRESHOLD CONCEPTS, OR, ON INTEGRATION

The integration after differentiation of which Kegan (1982) speaks is the act of reorganising the essence of one’s way of knowing into a new balance. And, as Lewis (2000) notes, self-organisation is a cross-scientific principle which ‘explicates the emergence of order in physics, chemistry, biology, ecology, and cosmology’ (p. 40). In describing threshold concepts as ‘integrative,’ and thereby ‘expos[ing] the previously hidden interrelatedness of something’, Meyer and Land (2003, p. 4) have captured the acts of reorganisation and accommodation (Piaget, 1950) that occur when individuals modify their existing cognitive structures to make sense of the external world. Perry (1970) remarks that these reorganisations are “sometimes [...] sensed as a ‘realization.’ This is particularly likely in respect to an insight or reconstruction that suddenly reveals ‘the’ meaning of some incongruity of experience we have been trying for some time to make sense of” (pp. 41–42).

Meyer and Land’s notion of integration is not purely cognitive, however, for it refers to the ‘indissoluble interrelatedness of the learner’s identity with thinking and language’ (2006, p. 21). The integrative nature of threshold concepts is thus also a matter of *integrity* – of the creation of a coherent way of knowing and being in the world. Boyd and Myers (1988) capture the emotion that characterises the final, integrative, phase of the grief work involved in transformational education as ‘movement [...] between a hope-filled sense of restabilization and reintegration of identity’ (p. 279).

We may turn now to the ‘newness’ of what has emerged through qualitative change. Wood (1998) emphasises that ‘the emergence of what is qualitatively new’ may be ‘understood in terms of the specific essence of that which is in process rather than in terms of general laws applying to simple elements of which it is composed’ (p. 2). These qualitative reorganisations, perhaps precipitated by what Meyer and Land (2005) term the ‘*reconstitutive* effect of threshold concepts’ (p. 375; emphasis added), represent the adaptation (e.g. Lewis, 2000) of an individual to his or her environment. And our very survival (biological, academic, or otherwise) depends on our ability to respond to the demands of our surroundings, to our ‘life conditions’ (Kegan, 1994).

Given the cognitive and emotional complexity involved in reorganising one’s epistemic beliefs, Dole and Sinatra (1998) comment rather unsurprisingly that reorganisation is difficult to achieve. As educators and as disciplinary experts, we must consider that we may hold either explicit or implicit expectations regarding the ‘appropriate’ response or adaptation to the troublesomeness or discrepancy introduced by a threshold concept. Our upcoming discussion of the bounded nature of threshold concepts will urge us to consider, however, that these expectations may arise from the multiple layers of context in which threshold concepts are embedded.

BOUNDEDNESS, OR, ON CONSIDERING CONTEXT

The view of learning expressed in this chapter raises the interesting and ethical question of whether development should be the aim of education (e.g. Fiddler and Marienau, 1995; Kohlberg and Mayer, 1972). This question is important to consider because educational ideologies influence the nature of the outcomes established for and valued in learners (Kohlberg and Mayer, 1972). Moore (2002), commenting on the inherently developmental nature of learning, states that according to Perry and other researchers, ‘true education, especially liberal arts education, was fundamentally about this kind of development – namely, the evolution of individuals’ thinking structures and meaning making toward greater and more adaptive complexity’ (p. 26).

Conceived of in this manner, the purpose of education is much less about fostering growth in *what* learners know than facilitating development of the *ways* in which they know. Such a perspective may partially allay Meyer and Land’s (2005) concern about threshold concepts being perceived as prescribing a rigid, unidirectional path toward achievement of particular goals, such as degree achievement or professional accreditation. Focusing on threshold concepts’ potential to instigate epistemological transformation enables us to emphasise learning as ‘entrance into [...] a community of people who share that way of thinking and practising’ (Davies, 2006, p. 71).

While it may seem nobler to discuss the development of ways of knowing and being, rather than the content of knowing, as the aim of education, we must first clarify an important matter. The preceding discussion of essence and end points, of transitions, trajectories, and thresholds in the development of epistemic beliefs

reveals an additional underlying philosophical assumption, most notably that there is something orderly and progressive in the way that learners construct meaning in their disciplines and in their lives. Yet, this organismic (or modernist) worldview of development (Goldhaber, 2000) has historically been criticised by those holding contextualist (or post-modernist) views for its failure to integrate a deep consideration for the role played by context in development. In a fascinating illumination of the modernism – post-modernism debate, Chandler (1995) eloquently describes post-modernism’s rebellion against modernism’s ideas of universal stages and sequences in development. Indeed, some post-modernists claim that development is so entirely context-bound, and individuals’ contexts so variable, that any attempt to search for universal patterns and endpoints in development is an attempt to perpetuate hierarchies and oppression. In his analysis of post-modern arguments against modern views of development, Chandler (1995) remarks, however, that

while a certain incredulity toward the grand political narratives of the past may well be justified, the same suspicions may actually not be appropriate when attention is re-focused on those smaller potato matters having to do with the separate psychological development of individual persons. [...] Many of post-modernism’s hallmark questions concerning the essentially political consequences of modernity may actually be irrelevant to the job of deciding whether there is anything like human nature, or universal trajectories in the course of individual psychological development. (p. 8)

Chandler’s thoughtful reflections on the post-modern view of development reveal a need for modernists to pay greater heed to the role played by context in development. Meyer and Land’s (2003) discussion of threshold concepts as ‘bounded’ and thereby ‘serv[ing] to constitute the demarcation between disciplinary areas’ (p. 5) provides an excellent point from which to begin examining the issue of context and its relationship to our developmental perspective of threshold concepts. If, indeed, the learning of threshold concepts is ultimately a matter of epistemological transformation, we might consider the discipline and its inherent epistemology (Meyer and Land, 2005; Perkins, 1997) as only one of the multiple, interacting layers of (epistemic) context in which threshold concepts are embedded.

We might begin by considering, at the macro level, the powerful historical, social, and cultural forces that converge (Goldhaber, 2000) and give rise to the relative prominence of certain disciplines. We may then consider how these forces shape, at the meso level, the epistemic context of the discipline itself; that is, the questions pursued (and funded) and the methodologies judged as appropriate for pursuing them (Perkins, 1997). At the micro level, we may investigate how these forces manifest themselves in the selection by members of the disciplinary community of concepts deemed important, even thresholds, and around which curricula and programmes are designed. Finally, we must consider the ways of knowing and meaning-making of individual learners. Recent research reveals that the development of individuals’ epistemic beliefs is shaped by these multiple layers of context (Palmer and Marra, 2008), as well as by more proximal influences, such

as religion and family (Gottlieb, 2007). We must therefore be prepared to accept variation in learners' cognitive and affective responses to our attempts to 'teach' threshold concepts.

The value of an approach that acknowledges the existence and influence of the multiple layers of interacting (epistemological) contexts in which threshold concepts are embedded allows us, in Kegan's terms, to make them 'object'. Consequently, rather than being impervious to their influence, we may hold them to light, examine them, and question their influence in shaping our current and future ways of knowing and being.

CONCLUDING THOUGHTS

With increased calls for accountability and the requirements of professional accreditation organisations, we must necessarily be concerned with, and attend to, the outcomes of learning in higher education. Indeed, we must have a clear vision of the direction in which we would like to take students. The questions raised in this chapter caution us, however, against making the acquisition of threshold concepts our sole focus as educators. We are perhaps reminded that increased attention to the learning *process* might help ensure that learners achieve the intended outcomes in a manner that recognises and respects the great cognitive and affective work they must do. Designing such developmentally-appropriate instruction involves having a deep understanding of learners' current ways of making meaning, for what we are facilitating is a process of epistemological transformation so crucial to learners' 'becoming': becoming disciplinary experts, and perhaps, most importantly, becoming more fully themselves.

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2. TRANSCENDING DISCIPLINARY BOUNDARIES

A Proposed Theoretical Foundation for Threshold Concepts

ABSTRACT

The constructs of reflective and defensive responses to rupture in knowing are proposed and evaluated as a discipline-independent theoretical foundation for the analytic educational framework of Threshold Concepts (TC). Two premises underlie this work: crucial elements of student experience of difficulty as they encounter existentially unfamiliar, educationally critical content of their respective disciplines occur in common across all disciplinary contexts; and these crucial elements constitute core issues defining the framework of Threshold Concepts. Universally relevant elements require investigation that transcends discipline boundaries in order to be understood well and addressed effectively. From the perspective of phenomenological analysis, student experiences of difficulty under these circumstances are considered to be founded in reflective and defensive responses to rupture in knowing, and to originate in universal human patterns of encounter and response to the existentially unfamiliar (what appears initially as the unknowable unknown), rather than to result from individual inadequacies or to differ in kind according to the context in which it occurs. A comparison of process and structure in the TC community with that of a classical scientific community of practice and research illuminates the process of generating candidate theoretical foundations in each.

INTRODUCTION

Threshold Concepts (TC) as an analytic educational framework was originated by Meyer and Land during their participation in the *Enhancing Teaching-Learning Environments in Undergraduate Courses* project (Meyer & Land 2005, p. 386). The term *threshold concept (tc)* refers to content of a discipline or profession that poses deep challenges to the learner (and the teaching of which this framework is meant to support). Much of TC work is addressed to considerations of *liminal space or liminality*, which refers to the period between exposure to a threshold concept and its acquisition. (*[The term derives] from Latin **limen**, 'boundary or threshold' ... to describe the conceptual transformations that students undergo, or find difficulty and anxiety in undergoing, particularly in relation to ... being 'stuck' ...* (Meyer & Land, 2005, pp. 373–377). Meyer and Land have come to regard an understanding of liminality as the *sine qua non* for the ongoing development of TC (Land, 2008).

Scholarship in liminality to this point has taken the form variously of description, metaphor, and analogy. Meyer and Land construe approaches to teaching within the TC framework as entirely discipline-specific, and have eschewed those that transcend disciplinary boundaries.

Background

Underlying Premises. This paper is predicated on two premises: 1) Crucial elements of student experience of difficulty as they encounter existentially unfamiliar, educationally critical content of their respective disciplines occur in common across all disciplinary contexts; and 2) These crucial elements constitute core issues defining TC. I agree with Meyer and Land regarding the importance of *liminality*, but diverge from their dismissal of scholarship transcending disciplinary boundaries. Faculty at TC conferences invariably recognize in each others' descriptions of student behavior – either at formal presentations or in informal conversations, and irrespective of discipline – depictions of their own students' response to encounters with deeply challenging content. Their consistent mutual recognition makes a strong case that the significance and potential of TC as an analytic framework derives from the universality of student experiences of difficulty in encounters with that content in any – and all – of their respective fields. One may conclude that, with respect to the nature of the learner's experience of difficulties in encountering – and the mechanism involved in her / his learning – deeply challenging content, many more elements of commonality than difference hold across disciplinary boundaries.

Certainly the specifics of learning deeply challenging, educationally critical content of a discipline (*tc's*) must be addressed within their respective disciplinary contexts. However, the very notion that liminality will likely be experienced by students in any (and every) field indicates that crucial elements of that experience – which constitute core issues defining TC – are unrelated to disciplinary context. This paper is motivated by an interest in developing TC scholarship of liminality beyond its current forms (description, analogy, and metaphor) to explanation. I argue that doing so requires a theoretical foundation through which these core issues can be investigated and understood independent of disciplinary context.

The argument is based in phenomenological analysis (not psychology or situational dynamics), according to which: student experiences of difficulty under these circumstances are considered to be founded in reflective and defensive responses to rupture in knowing, a universal human pattern of encounter and response to the existentially unfamiliar (what appears initially as the unknowable unknown), rather than to result from individual inadequacies or to differ in kind according to the context in which it occurs. I propose the constructs of reflective and defensive responses to rupture in knowing as a discipline-independent theoretical foundation for TC.

Origins. The proposal grows out of an exploration of student encounters with the existentially unfamiliar, educationally critical content of computing science (my discipline), where such a framework has proved relevant and illuminating.

Its application in my discipline-specific work was motivated by – and done in preparation to address – the questions of how to engender reflective responses in all students at all times, or, among those students who do respond defensively, how to cultivate transition from defensiveness to reflectiveness (Schwartzman 2007, 2008). Because the conceptual framework organizes exploration around student response to what appears unknowable, rather than discipline content, it transcends disciplinary boundaries.

Organization of the Paper

The paper begins with an introduction to Threshold Concepts (TC) and threshold concepts (tc) and proceeds in sequence: an exposition of motivation and preparation for defining a theoretical foundation (in several parts); a comparison of process and structure in the TC community with that of a classical scientific community of practice and research, which illuminates the process of generating candidate theoretical foundations; a literature-based description of reflective and defensive responses and the rupture in knowing that gives rise to them, as well as the larger context of learning in which all three are situated; an excerpt of student feedback data in my course, from which the work underlying this paper originated; a proposal of the aggregated two response types as a discipline-independent theoretical foundation, both for this investigation specifically, and by extension for TC scholarship more generally; application and evaluation of the candidate theoretical foundation and the associated explanatory theory defined by it; a view toward possible future work.

THRESHOLD CONCEPTS (TC) AND threshold concepts (tc)

The Concept

TC: informally. The frame of Threshold Concepts (TC) is generally understood as an orientation in teaching, for any discipline, that is concerned with how to support students' learning particularly challenging material, aka threshold concepts (tc's).

tc: more formally, definitions. Meyer and Land speak of tc's as conceptual gateways or portals to an otherwise inaccessible – and unknown – conceptual space or way of understanding. *Such conceptual gateways [are characterized as] **transformative** (occasioning a significant shift in the perception of a subject), **irreversible** (unlikely to be forgotten, or unlearned only through considerable effort), and **integrative** (exposing the previously hidden interrelatedness of something).* Transition through the portal to the new space often poses difficulty and is experienced as *troublesome*. The new space is itself *bounded* (bordered by thresholds into further, currently inaccessible conceptual territory) (Meyer & Land, 2005, pp. 373–377).

TC: the entity

The term Threshold Concepts covers a variety of denotations, including an approach to teaching, an existing body of scholarship, and a structure of community.

An approach to teaching. TC is generally understood to mean an orientation toward supporting student learning of deeply challenging material. A concern for student learning, and an emphasis on teaching to support that learning, operate as defining characteristics of this community.

A body of scholarship. Two international TC conferences have been held thus far (2006, University of Strathclyde, Glasgow, Scotland; and 2008, Queen's University, Kingston, Ontario, Canada). Presentations were concentrated in several areas specified by the conference organizers: some analysis, but primarily description of teaching, of liminality, of candidate tc's within a discipline, and of observable student behavior; as well as interpretations of liminality through analogy and metaphor. TC scholarship is initially developing from a variety of sources in a variety of what appear as not-necessarily connected directions; an eclectic mix of description, analogy, and metaphor.

Community structure. The formation, practice, and scholarship of the TC community occur among a membership of individuals who remain committed to their respective disciplines as a primary focus, while also concerned that students learn the deeply challenging material contained therein. This assemblage of individuals is establishing the TC community as an area of common secondary (or occasionally co-primary) focus.

TOWARD DEFINING A THEORETICAL FOUNDATION:
MOTIVATION AND PREPARATION

Content and structure of the TC theoretical foundation is shaped by the role(s) of theory generally in the ongoing development of a field. Content is also shaped by both the requirements the foundation must satisfy and the central question(s) it must address.

The Role(s) of Theory:

From the literature. Padfield notes, in considering the relationship between theory and practice, that [*b*]enefits of learning from experience may not materialize without the ability to order [*that experience*] into understandable patterns and apply theoretical frameworks (Padfield 1997 p. 91). Most (perhaps all) educators currently drawn to TC are impelled by their experience in teaching discipline-specific content that students find challenging. If some theoretical framework orders such experience – both individually and collectively – into consistent and meaningful patterns, the framework would have value as a communal resource for both teaching and scholarship.

Gurwitsch concisely states the purpose of theory in formal logic; it can be applied here as well: While the practitioner can rely on the nature of a particular conceptual tool as a ‘*matter of course which goes without saying*’, the theoretician of the discipline has a different task: *to make such tacit presuppositions explicit, to thematize them* [i.e., to place them in their meaningful context], *and to see and attempt to solve their problems* (Gurwitsch 1974 p. 66).

A *theoretical foundation* for any field plays multiple roles. Among those discussed in this paper: 1) It clarifies the nature of a developing field by illuminating an internal coherence among the existing theoretical and applied work, unifying into a body of literature what had appeared as fragments scattered into a variety of not-necessarily connected directions. 2) By defining problems to be addressed and solutions that can be accepted – as Kuhn (1996) describes the role of paradigm – it informs (as organizing principle) future theoretical and application development. 3) It defines an *explanatory theory* for practice within the field (Gurwitsch 1974 p. 81).

An *explanatory theory* defined for TC (whether by the proposed theoretical foundation or otherwise) is required for maturation of the field (Gurwitsch 1974) and education into it. Among its multiple roles: 1) It provides (beyond description, analogy, and metaphor) meaningful explanation(s) of students’ experience as they encounter deeply challenging content. 2) It enables faculty to devise more effective teaching strategies for that content by dint of those explanations. 3) It furthers discourse to refine both the designation of what constitutes such content within a discipline and the representation of conceptual elements within TC. 4) It supports a *separation of concerns* (Dijkstra 1972) within TC by, for example, refining and clarifying terminology, and making assumptions explicit.

For this paper. Husserl’s view of psychology as a discipline (summarized by Gurwitsch) also applies here: For [it] to be founded and established as an explanatory science, i.e., a theoretical discipline, principles of theoretical explanation are required that can be derived only from a conceptual system (Gurwitsch 1974 p. 81). Such a formulation describes the structure and content of this paper: I propose, as the relevant conceptual system, reflectiveness and defensiveness in response to rupture in knowing; and as principles of theoretical explanation, the setting and implications that are defined as its associated explanatory theory.

Requirements

Transcending disciplinary boundaries. A distinction is noted between the deeply challenging, educationally critical content particular to a discipline, and the universality pertaining to crucial elements of student experiences of difficulty as they encounter such content. Any theoretical result that accounts for universal aspects of student experience by using discipline-specific explanations (the current structure of TC scholarship) cannot be applied across disciplinary contexts. A valid explanatory theory for these crucial elements – and thus its underlying theoretical foundation – must remain unbound by disciplinary context and free of discipline-specific content.

A resource for teaching faculty. Many presenters at the 2008 TC conference spoke about their attempts to reach disengaged, even disaffected, students, and their various successes or difficulties in doing so. A theoretical foundation for TC (and its defined explanatory theory) should serve as a resource for such faculty; suggesting meaningful interpretation(s) of student behaviors and expanding the discourse to explore their causes and origins (Gurwitsch 1974).

Resolving Lacunae: representations of student experience. Lacunae remain in the definitions stated above for threshold concepts. All defining characteristics, except for *troublesome*, describe the aftermath – not the experience – of students' successful acquisition of challenging material. In themselves, these characteristics include no reference to what would facilitate teaching tc content. Like tc's, liminality has been defined by its consequences: anxiety; and by its hoped-for consequences: transformation and ontological shift. To date, TC scholarship regarding liminal space employs a metaphor from anthropology concerning states of being defined by social structure, and transitions among them (Turner 1969, Meyer & Land 2005 p. 375). It depicts implications of journey through that space as transformations or ontological shifts, but does not address the nature of either the space or the journey. In itself, the definition includes no information that facilitates supporting a student on the journey. A theoretical foundation for TC (and its defined explanatory theory) should serve as resources for resolving such lacunae, suggesting useful possibilities to facilitate teaching tc content and support students experiencing difficulty in the face of that content.

Rigorously defined terminology. Existing TC terminology conflates elements with distinct, even divergent meanings, and implicitly expresses assumptions that may not hold; making careful analysis more difficult. For example, “threshold” can be understood to refer to both the experience and the content of an encounter with deeply challenging material. It can also imply that to learn means to be hoisted over an existing (provisionally) stable threshold in a fixed world, so that the *individual acquires ... a new status and identity* (Meyer & Land 2005 p. 376). A theoretical foundation for TC (and its defined explanatory theory) should serve as clarifying resources, enabling greater precision in terminology – and thereby in scholarship.

Questions to be Addressed

A traditional scientific community participates in a *coherent research tradition* (Kuhn 1996 p. 46) delineated by – and communicated through – its extant paradigm. In a traditional scientific field, the paradigm grows out of the central motivating question for the discipline. No such question has yet been defined – or even explicitly sought – in TC scholarship. I propose a central question for TC, and pose it from three perspectives, those of:

- 1) the practitioner teacher: *How to ensure students' learning of deeply challenging material?*

- 2) the describer scholar: *How to ensure students' productive journey through liminality?*
- 3) the theoretician (who makes tacit presuppositions explicit): *What constitutes student learning of deeply challenging material? What happens in an encounter with deeply challenging material? What constitutes liminality?*

The central issue of learning may be pursued in either (or both) of two directions: the **operation** of learning, identifying what it means to have learned; or the **mechanism** of learning, exploring how learning happens. For the former direction, one may use existing and well-established methodologies such as Bloom's taxonomy. Its application, while yielding valuable information, is defined in a discipline-specific way; the results in one area cannot be applied directly to another. Furthermore, it cannot answer the theoretician's multiple questions. Pursuit in the latter – and more challenging – direction is not defined in a discipline-specific way; the results based on one academic or professional area can be applied directly to another. It would also encompass the theoretician's multiple questions.

Teaching faculty drawn to TC are invariably seeking to support student learning. Thus, any useful explanatory theory must address the experience of encounter with deeply challenging content and the process of learning it (productively navigating the ensuing interval of confusion) – or not. The theoretical foundation proposed here (and therefore any explanatory theory defined by it) arises exactly from consideration of the nature of the **encounter** itself, its operation (what occurs), and mechanisms (how it occurs), and their correspondence to possible outcomes.

GENERATING THEORETICAL FOUNDATIONS: COMMUNITY STRUCTURE AND PROCESS

In this section, the structure and process of TC is contrasted with that of a classical scientific community profiled by Thomas Kuhn (1996). It is assumed without discussion that an operative paradigm resembles the explanatory theory defined by an extant theoretical foundation.

A classical scientific community. Thomas Kuhn profiles a classic scientific community of practice and research in *The Structure of Scientific Revolutions* (Kuhn 1996). Kuhn writes about *communities* as the locus of discipline-specific development and discovery. A critical point – so fundamental that it is simply taken for granted and not articulated in the book (likely a *tacit presupposition* on Kuhn's part) – concerns the central and defining role of that particular discipline in community members' professional lives. Conversely, the discipline is completely defined by members' professional practice and scholarship. This process of reciprocal definition is effected through the conceptual construct of (in Kuhn's terminology) a *paradigm*. A paradigm arises from a set of *universally recognized [discipline] achievements [and] for a time provides model problems and solutions to a community of practitioners. ... The defining achievements were sufficiently*

unprecedented to attract an enduring group of adherents away from competing modes of [discipline] activity ... [and] ... sufficiently open-ended to leave all sorts of problems for the redefined group of practitioners to resolve ...

The practices of both development and discovery in science *are community-based activities. To discover and analyze them, one must first unravel the changing community structure of the [discipline] over time.* During periods of development, *a paradigm governs, not subject matter but ... a group of practitioners.* During periods of discovery, a shifted paradigm is forged by the concentrated collective intention of a group of practitioners. *Any study of paradigm-directed [i.e., development] or paradigm-shattering [i.e., discovery] research must begin by locating the responsible group or groups. ... The pre-paradigm period, in particular, is regularly marked by frequent and deep debates over legitimate methods, problems, and standards of solution, though these serve rather to define schools than to produce agreement* (Kuhn 1996 pp. x, 10, 46, 47, 179, 180) (all emphasis added).

Illuminating TC

Differences and implications. The formation, practice, and research of a scientific community profiled by Kuhn is impelled by a profession-defining, concentrated, collective intention among its members. They act to formulate and rigorously pursue the most productive questions (from which a theoretical foundation typically evolves) in a content area of shared primary focus. Community cohesion – even perhaps existence – depends on continuing evolution of a workable paradigm. Education into the field does not merit significant attention. In contrast, TC typically occupies a position secondary to their respective disciplinary pursuits in most participating faculty’s professional lives. Concern for education and effective teaching defines the TC community. Rather than disputing each other’s suggestions (the rigorous debate Kuhn mentions), most of the individuals interested in TC that I have met display receptivity to – even hunger for – any and all ideas about how to support student learning.

Given the combination of secondary focus and readiness to consider proffered solutions, TC is missing the traditional structure and implicit procedures for rigorously producing a paradigm. It lacks the stimulus for normatively generating a set of theoretical foundation candidates, as well as any process for determining the most viable from among the collection of associated explanatory theories. No widely accepted initial paradigm has been established, and the community has engaged in none of the debates that characterize classic pre-paradigm status.

TC: on its own. Lacking an operative paradigm, TC is valued as an agent of connection and communication by committed teachers who seek others of like mind. TC provides a common vocabulary for discourse and a meeting ground at conferences for a coalescing multi-disciplinary community of teaching practice and descriptive scholarship. Such a community plays a critical role in the ongoing development of faculty who are teaching in their respective disciplines, and even of the disciplines themselves (Lister 2008).

A REFLECTIVENESS / DEFENSIVENESS CONCEPTUAL FRAMEWORK:
THE PROPOSED THEORETICAL FOUNDATION

This section introduces the conceptual framework of reflectiveness and defensiveness. A lay person's view of the two is summarized first. A deeper analysis follows, after being set in context.

Reflective vs. Defensive Responses: the Layperson's View

From the layperson's perspective, reflectiveness and defensiveness are understood as radically different from each other. Defensiveness is associated with an incident-specific increase in emotion that overshadows other aspects of an encounter and effectively prevents further discussion of the topic at hand; in shorthand, an ad hoc reaction of: "NO, DON'T". Reflectiveness is associated with diminishment of emotional investment, a kind of long-term stepping back to see better; in shorthand, an attitude of: "Hmmm, I wonder..." Though widely held, these definitions by association do not provide any insight into the origins, operations, or mechanisms of reflectiveness and defensiveness. A deeper analysis follows.

Setting Context: Diverse Sources and Multiple Values

Extending a metaphor from Plack and Greenberg (Plack & Greenberg 2005 p. 3), learning comprises two main aspects, and can be likened to the double helix of DNA. One strand holds the cognitive content specific to a particular domain or discipline; it is acquired by cognitive effort, including memorization. One strand, the focus of this proposal, is composed of context, meaning, and their interplay; it is acquired through reflectiveness, a practice common to all fields of learning. As befits the cross-disciplinary nature of TC, for this paper I draw on literature from a number of disciplines and professions, all directed toward the second strand of learning.

TC practice bespeaks an approach to teaching that is value-laden with respect to reflectiveness, because educators want students to respond reflectively. However, that value-laden orientation may blind one to the possibility of exploring and examining the absence of reflectiveness (a circumstance of many students' experience, and one that must be accounted for by any explanatory theory). Thus, (the search for) a theoretical foundation must take a value-neutral orientation regarding reflectiveness – and defensiveness: rather than being concerned with how one can engender a particular (reflective) response, one explores how students actually do respond to existentially unfamiliar, educationally critical material within a discipline. Following Segal's example (Segal 1999), this sort of exploration in theory produces information epistemologically prior to – and useful for – engendering in practice the desired reflectiveness.

Elements of Explication for Reflectiveness and Defensiveness

This subsection draws primarily on the work of three individuals to explore the roles of meaning and awareness: Jack Mezirow served as an Education Department Chair at Columbia University and reported on both his own research and a wide

spectrum of scholarship related to transformation theory (Mezirow 1991). John Dewey (Dewey 1991) played a seminal role in the development of modern education practice and theory. Phenomenologist Aron Gurwitsch, a student of Husserl, suggested that universal patterns of organization characterize fields of consciousness and inform the development of awareness (Gurwitsch 1964).

Meaning. *Meaning* amounts to a coherent representation of experience, an interpretation that occurs *both prelinguistically and through language ... by processes involving awareness* (Mezirow 1991, p. 4). Meaning arises out of experience, it cannot be arbitrarily imposed. *Saliency of a group of data so that this group emerges and segregates itself from the stream [of experience] is a feature not introduced into the stream, but yielded by the stream itself* (Gurwitsch 1964, p. 31), (James 1890). Dewey believes that the exercise of intelligence requires the existence of meaning; to grasp meaning constitutes the *nerve of our intellectual life*. For Dewey, individual learning may be defined as making meaning; what one can interpret effectively, one understands both differentiated from and in relationship with its surrounding context (Dewey 1991, pp. 116, 117).

Meaning frames. Meaning-making takes place under an orienting frame of reference, a *structure of assumptions within which one's past experience assimilates and transforms new experience, ... a habitual set of expectations*. I use the term *meaning frame* for such structures, which embody the categories and rules that order new experience, shaping how we classify our encounters with the world: what we take in and how we act. They also dictate what we notice and what we ignore by *selectively determin[ing] the scope of our attention ... informed by an horizon of possibility, ... to simplify, organize, and delete what is not salient in sensory input ... and provide the basis for reducing complex inferential tasks to simple judgments*. Thus, they function as both *lions at the gate of awareness and the building blocks of cognition* (Mezirow 1991, pp. 49, 50). Thomas Kuhn (1996) introduced the term *paradigm* to describe the analogous structure(s) within scientific communities of scholarship: a collection of unspoken expectations for, assumptions about, and model of relevant aspects of the world.

Dewey states that *[e]xplicit thinking goes on within the limits of what is implied or understood*, and describes the role of these 'premises', the grounds or foundations, in reasoning: the premises contain the conclusions and the conclusions contain the premises. The importance of coherence as an organizing principle is embodied in that relationship (Dewey 1991, pp. 81, 215). Meaning frames operate below the level of awareness, as an unarticulated, *unconscious* system of ideas. They inhabit the realm of the unseen, taken-for-granted: *The old, the near, the accustomed, is not that to which but that with which we attend* (Dewey 1991, p. 222).

Meaning frames exist as dynamic entities. In the normal course of our encounters with the world, meaning frames undergo continual refinement; one's *selective and conceptualizing faculties are persistently at work* (Gurwitsch 1964, p. 30). Encounters with the world also occur outside that normal course: Dewey observes that any aspect of the world, no matter how well known, may suddenly

present an unexpected and incomprehensible problem (Dewey 1991, p. 120). This section and the next lay groundwork for understanding the (relevant to TC) consequences when meaning frame refinement does not suffice.

Awareness and the organization of consciousness. Meaning frames refer to what one brings within oneself to engage in and interpret an encounter with the world. The work of Aron Gurwitsch enables reference to those aspects of the world that one takes in or one acts upon through the meaning frame. He asserts that every field of consciousness, regardless of content, exhibits a *universal, formal pattern of organization* comprising three domains or dimensions: the *thematic focus* or *theme*, upon which one's mental activity concentrates; the *thematic field*, aspects of the world co-present with the thematic focus and having relevance to it; and the *margin*, aspects of the world co-present with the thematic focus but irrelevant to it (Gurwitsch 1964, p. 56).

Meaning frame operation and field of consciousness organization exist interdependently. Meaning frame dictates what aspects of the world one's awareness encompasses at any given moment, which elements among them have direct significance (corresponding to what occupies the thematic focus); which have significance by association, i.e., *relevance* (corresponding to content of the thematic field (Gurwitsch 1964, p. 341); and which have little or no significance (corresponding to marginalia).

Booth summarizes Gurwitsch's work: The structure of awareness may be thought of as a dynamic relationship between oneself and the object of one's consciousness. One brings the totality of one's experience and awareness to the perception or consideration of some aspect of that object. The object is said to 'present' itself in that awareness; how it does so determines the thematic focus to emerge from it, and the attendant elements of relevance constituting the thematic field. A shift in one's awareness to another aspect of the object brings a corresponding shift in the thematic focus and thematic field. In contemplation of an object, one shifts one's awareness alternately among its different aspects. Each attendant shifting organization of the dimensions of one's consciousness may be enacted by delineation of a different element from the thematic field into thematic focus (Booth 1997, pp. 141,146).

Two critical implications follow from this relationship: The more differentiated one's view of an object (the more aspects one can bring awareness to), the richer the set of elements in the thematic field associated with it and the more varied the set of elements that can serve as a thematic focus during contemplation of the object; thus, the deeper one's understanding. In contrast, a sparsely populated – or empty – thematic field leaves little possibility for deep understanding.

Etiology of Reflectiveness and Defensiveness: A Phenomenological Analysis

Heidegger describes a pattern of encounter with and response to the existentially unfamiliar that he calls the *dynamic of rupture*. Segal's explication of the dynamic (Segal 1999, Heidegger 1927) lays groundwork for a functional definition of

rupture and phenomenological analyses of reflectiveness and defensiveness. The dynamic takes the form of a three-step sequence: *rupture*, *explicitness*, *response* – either *reflective* or *defensive* (Segal also refers to the response types as alternative forms of *explicitness*). I draw on the literature to examine each step in turn, as well as several underlying concepts on which they're based. The results enable an expanded and refined description of reflectiveness and defensiveness, their origins, differences, and similarities; in preparation for demonstrating their relevance as a foundation to an explanatory theory for TC.

Dynamic of rupture: definition by example. This dynamic can be explained by Segal's example from Dreyfus (Dreyfus 1993) familiar to anyone who is traveling internationally for the first time, perhaps to attend a conference: Each of us 'knows' what particular distance to stand apart from an acquaintance when engaged in conversation. In general, one has no awareness of the specific distance, or even that one is doing it. This 'know-how' resides in the realm of the unseen taken-for-granted. However, when one encounters conference host country natives who use a different conversational distance, one experiences them as standing uncomfortably close or uncomfortably far away, and one suddenly becomes aware that one has an accustomed distance. As will be explained, this discomfort is experienced either productively (reflectively) or unproductively (defensively). Segal's explanation of distinct forms of differentness clarifies the two possibilities. (Note that the traveler's responses in this section actually occur below the level of awareness and language; they are verbalized here for the reader's information.)

Segal, citing Bauman, distinguishes between two kinds of differentness or otherness: the oppositional (in shorthand, *enemy*) and the unknown (in shorthand, *stranger*). The oppositional is defined according to the same rules as oneself, but oppositely. Continuing the example of interpersonal conversational distance, the international traveler may respond: "These unrefined (host country) natives are standing the wrong distance away. I can't possibly carry on a civilized conversation under such conditions."

Their differentness is thus defined in opposition: their 'wrong' vs. one's own 'correct' distance, 'unrefined' vs. 'refined' nature, 'uncivilized' vs. 'civilized' actions. Defining the other in opposition, as *enemy*, confirms one's view of the world; questioning of one's own or the other's behavior has no place. *Enemies* oppose each other but have a common appreciation of the terms on which they meet; *[they] function in the space of the existentially familiar ...*

Alternatively, the unknown is defined by unknown rules, or perhaps not defined at all. The international traveler may respond, "What is happening here?", and eventually, "What does this mean? Do I have an accustomed distance? If so, how did I learn it, what length is it measured at? Do they have an accustomed distance? If so, how do I learn it, what length is it measured at, and how do I figure it out? How long will it take to learn, what will I do in the meantime? ..." Recognizing the other as unknown, as stranger, evinces the inadequacy of one's worldview; questions, but no real answers, abound. *Strangers* have no common understanding of the terms on which they meet; *[they] give rise to the existentially*

unfamiliar ... [T]here are no ways of reading [such] a situation that can be taken for granted. ... The anxiety of strangeness is experienced not only in the face of the stranger but in the face of strange and unfamiliar situations – in any situation in which we cannot assume our familiar ways of doing things (Segal 1999 p. 76, Bauman 1990 pp. 143–145).

Enemies and friends, or enemies and oneself, represent two sides of the same coin. Strangers – or strange, unknown situations – represent a different coin altogether.

Note that in this example, conversation with host country natives constitutes the object of the traveler's consciousness, and standing distance between her and them becomes the thematic focus. Elements in the thematic field include observations (of host country natives talking among themselves, out-of-country attendees talking among themselves, and natives and attendees talking with each other); and recollections (of standing distance in conversations at home with close friends or family, or with strangers, and how that distance varied depending on conversational content and the nature of the encounter).

Troublesome knowledge and rupture in knowing. Anomaly refers to experience or observation that violates the expectations carried in one's meaning frame. *Troublesome knowledge* denotes an anomaly that cannot be avoided, ignored, or made to conform, leading to a rupture in knowing. Not all anomalies rise to a level of troublesome knowledge; persistence and significance, at a minimum, are required. *Rupture in knowing* (my terminology) arises when *what is known and what must be understood ... conflict*. (Mezirow 1991 p163, Loder 1981). It is created by a conflict or mismatch between one's comprehension of relevant aspects of the world and one's encounters with or observations of those aspects.

It should be noted that anomaly and troublesome knowledge are defined entirely in relation to one's meaning frame, and occur as a violation of expectations carried therein. The frame is required to bring the anomalous nature of a phenomenon to light, but inadequate to resolve the problems raised by its existence (Kuhn 1996 p. 122). In the absence of an extant meaning frame, by definition, neither anomaly nor troublesome knowledge exist. In the example of the traveler, her meaning frame for conversational standing carries the habitual distance to which she'd been socialized; the phenomenon of host country natives' standing distance is defined as an anomaly in relation to it. If the occasional host country native stands at an unaccustomed distance, the traveler can attribute it to that individual's eccentricities. But if virtually every host country native does so, the anomaly becomes troublesome knowledge, an unavoidable phenomenon whose existential strangeness cannot be ignored.

Responses to and consequences from rupture in knowing. According to Mezirow and Dewey, an instance of rupture in knowing forces the inadequacies – and the existence – of one's meaning frame into awareness (*explicitness*, in Segal's explication of Heidegger's dynamic). The sudden unexpected presence of heretofore unseen, taken-for-granted elements in the thematic focus and thematic

field(s) of one's consciousness is accompanied by the *shock of estrangement* (Segal 1999) and experienced with much uncertainty and unease. These significant affective components are included in the challenges of explicitness. Segal notes that both cognitive and emotional elements are involved in the responses to rupture and explicitness, because high emotional arousal, either anxiety or excitement, forms an integral part of being attentive. Rupture and explicitness become the requisite, defining pre-condition to subsequent responses, which are restricted to two possibilities: either one avoids those challenges (a defensive response), or one takes on those challenges (a reflective response). Both reflectiveness and defensiveness are freighted with uncertainty and anxiety, and either can follow equally from explicitness.

LEARNING – OR NOT:
CONSEQUENCES OF REFLECTIVENESS AND DEFENSIVENESS

The reflectiveness/defensiveness conceptual framework, which comes to light through effecting the dynamic of rupture, resides within a broader context of learning generally, as illustrated in this section's descriptions of the nature and consequences of reflectiveness and defensiveness.

Defensiveness

The operation of defensiveness (avoiding the challenges of explicitness) shields the responder from having to experience the estrangement and engendered unease and uncertainty. According to Segal's account of the mechanism of defensiveness, it is enacted by *projection* (Segal 1999 p. 86). One disassociates from the uncertainty by recasting the unknown (strange) explicit as the known oppositional (enemy) explicit; one disowns the unease by projecting or displacing all responsibility for difficulty onto that recast source.

As an example, consider the first possible response attributed to the international traveler above. He casts the host country natives as unrefined clods, and (dis)places onto them all responsibility for a lack of productive communication. Details of natives' actual standing distance among themselves and with other visitors, and details of the traveler's and others' habitual behavior in his home country, merit no consideration. In fact, they have no place.

Reflectiveness and Transformative Learning

Reflectiveness (taking on the challenge of uncertainty and its affective components by engaging with the unknown as unknown) serves as the mechanism of transformative learning. The operation of transformative learning – the (eventual) reformulation of meaning frame after an instance of rupture in knowing – preserves meaning to effect coherence across that discontinuity. With a new meaning frame, one is re-oriented in the world: the same collection of experience, organized along different principles, embodies a radically different set of relationships. In Dewey's terms,

[a clarity illuminates] relations of interdependence between considerations previously unorganized and disconnected ... binding isolated items into a coherent single whole (Dewey 1991 p. 80). Using Gurwitsch's framework, the field of consciousness changes as a result of transformative learning: elements formerly not found in any domain of consciousness, possibly including component parts of elements formerly classified as nondecomposable, now occupy the thematic focus or reside in the thematic field, and some elements formerly found there are now relegated to the margin.

The operation of reflectiveness corresponds to steps 2, 3, and 4 in Barer-Stein's phenomenological analysis of learning as a five-step process of experiencing the unfamiliar: [1)], *being aware ... [characterized by the dominant question,] What is this?; [2)], observing ... How does this compare with what I know?; [3)], acting ... Shall I try it?; [4)], confronting ... Do I know this?, Do I want to?; [(if yes), then] [5)], involving ... How did this come to be?, What are the possibilities, and which makes sense?, What [meaning] is relevant for me?* (Mezirow 1991 p. 84, Barer-Stein 1987). As an example, consider the second possible response attributed to the traveler.

The mechanism of reflectiveness is not well understood; it remains *perhaps ... permanently inscrutable* (Kuhn 1996 p. 90). It might be described briefly (and vaguely) as follows: Once explicitness forces the inadequacies – and the existence – of one's meaning frame into (at least somewhat) conscious awareness, one engages in some combination of conscious and unconscious (Dewey 1991 p. 217) examination of the frame, to determine its inadequacies and correct them. The process is *terminated by ... a relatively sudden ... unstructured event [experienced as] a gestalt switch* (Kuhn 1996 p. 122), corresponding to the newly reformulated meaning frame that is required in order to accommodate the (now formerly) troublesome knowledge. The five-step sequence is thus compressed to: *discontinuity → reflectiveness → new meaning frame*, or (conforming more to case study course student data): *confusion → struggle → expanded knowing*.

Revisiting the TC / tc Central Question(s)

In light of the proposed theoretical foundation, TC central question(s) can be reformulated.

- 1+) from the TC practitioner teacher: *How to ensure students' reflective response to an encounter with the existentially unfamiliar, educationally critical content of the discipline?*
- 2+) from the TC describer scholar: *How to describe students' (reflective) response to an encounter with the existentially unfamiliar, educationally critical content of the discipline?*
- 3+) from the TC theoretician, (who is tasked with addressing epistemologically prior considerations (Gurwitsch 1974), which here means understanding how students actually do respond to such encounters and the mechanism(s) of their responses): *What actually occurs in an encounter with the existentially unfamiliar, educationally critical content of the discipline? How does it lead – or not – to learning?*

DATA: PARTICULARS GIVING RISE TO THE UNIVERSAL

Segal has studied the relationship between reflective practice – or its lack – and the interval of confusion that follows an encounter with the existentially unfamiliar. Based on his paper, I assert that a student’s exposure to troublesome knowledge in the content domain of a discipline initiates a rupture in knowing, and culminates in reflectiveness or, alternatively, defensiveness.

The current state of education into computing science (my discipline) derives from both immaturity and complexity: no consensus yet exists on a definition for good quality in software, and little beyond complexity is found as a common element among all software. This combination abstracts out much discipline-specific content and places in bold relief the issues surrounding student transformative learning – or not. Their exploration can produce results applicable to arbitrary disciplines. Due to space constraints, only a small amount of data is contained here, fuller treatment can be found in (Schwartzman 2007, 2008). In addition, perhaps readers who are drawn to TC will find data closer at hand through their own experience of teaching.

Case Study: A Data Source

The contents of this paper were motivated largely by the experience and outcomes of teaching in my discipline, including an upper-level undergraduate software design and engineering course (which is meant to teach software development fundamentals in a way that transcends software tools and languages, yet engages students in the actual practice of software, not just a theoretical or anecdotal exposition). Data is collected from several sources within that course: all students submit course assignments; some students record and organize thoughts in their group project task log; every student is interviewed at end of term in order to determine the extent of her / his individual learning beyond the group’s collective assignment submissions; and students submit anonymous course evaluations at term end. The literature on reflectiveness and defensiveness, especially Segal’s article, sheds considerable light on this extensive set of data, through which the course has become a case study for exploration into students’ response to deeply challenging content. Data sources are noted.

Representative Data and Analysis

Retrospective indications of reflectiveness: end-of-term interviews. In the case study course, reflectiveness is evidenced retrospectively by students’ end-of-semester accounts of transformative learning (the consequence of reflectiveness) in software development. They contrast prior practice (invariably, *It’s all about code*) with that now in place, indicating radical – even previously unimaginable – changes and their powerful implications. Consider one student response to the question, ‘What will you take away with you from the course?’:

(S_r104): Analyzing problems, analyzing software, and ways to go about developing software. I used to code software offhand without going off and thinking about it [first]. This course really helped me to go off and think about it. I’m not afraid

anymore to program, I know that. The real duty behind software development isn't code. Code equals a small percentage. Really: it's sitting down and really thinking it out. ... Now, I don't think about program in terms of lines of code, how many functions. Problems don't seem as big as they used to, they're simplified. [Now,] I'd take a project, break it down to its core elements, and really focus on ... [w]hat is the underlying problem, what underlying job needs to get done? Break down the problem into pieces, each piece has its own duty or task, functionality. Instead of a big, round ball, [it becomes] things more like blocks.

Retrospective indications of defensiveness: anonymous end-of-term course evaluations. In the case study course, retrospective projection onto the teacher and course structure of all responsibility for difficulty in class is interpreted as evidence of defensiveness, for example, this student's comments:

(S_IA1): I think this class was much more difficult than it had to be. ... My main concern was trying to interpret what was being asked, instead of learning the material. A separate point – we spent 2 periods going over the [KWIC index program] – Why? Why the line by line analysis of the ... program? This has little value – except to confuse and bewilder the class.

In-process feedback: indications of anxiety. Almost all feedback data collected at semester's end (representing after-the-fact reportage) satisfies exactly one of the defining conditions delineated in the previous section. However, for most of the group project, qualitative data logged in the midst of students' actual process does not satisfy either definition. It does consistently display a heightened level of affect, indeed anxiety, even among students whose projects later turned out well. Consider student entries from week 1 of the project:

(S_m201): ... It seems to me that we were not getting anywhere very quickly and this undertaking was larger than I previously had thought. What seems like such a straightforward assignment has become very complex ...

(S_m202): ... I'm a very calm and balanced person, and never really get stressed out about anything homework-wise because of the timeline I usually follow when I work. This project is already starting to stress me out because of the seeming lack of progress that we've gotten through so far. It seemed to me to be a fairly straightforward assignment at first, especially given the examples of the circles and the KWIC index, and I had hoped to hammer out a good outline to the [documents] within the first two sessions. We're nowhere near that yet. ... It feels like we're getting nothing done, and right now I don't necessarily know where to work next on my own.

These entries confirm the relevance of Segal's analysis; students are experiencing (effects of) explicitness: the confusion that follows exposure to – but precedes learning (or not) of – existentially unfamiliar material. Distinctions that retrospectively identify reflective and defensive responses do not apply. Analyzing in-process data to distinguish between the two response types poses much more

challenge than interpreting feedback given retrospectively, a difference relevant to the TC community concern with understanding and supporting student encounters with challenging material.

These students' group produced an extremely strong project, and their respective individual practices were significantly transformed by completing that project; indicating retrospectively that they responded reflectively. Their journal entries during the project indicate heightened levels of anxiety. Note, therefore, that in-process anxiety does not necessarily equal defensiveness, and reflectiveness neither equals contemplation nor means diminished affect.

THEORETICAL FOUNDATION: EVALUATING THE CANDIDATE

In this section, the proposed candidate theoretical foundation is considered in light of the roles a theoretical foundation should play: illuminating coherence and meaning in the body of existing literature, providing an organizing principle out of which the field can continue to emerge in a coherent way, and defining an explanatory theory for practice.

Illuminating Internal Coherence of Existing TC Literature

Real learning requires stepping into the unknown, which initiates a rupture in knowing. The interval of difficulty that follows exposure to existentially unfamiliar, educationally critical material can be understood as a response to that rupture. It is filled with confusion and uncertainty, even when it is also filled with learning (Brown *et alia* 2001). In the language of Heidegger's *dynamic of rupture*, the interval comprises a form of (response to) explicitness; that is, reflectiveness or defensiveness. By definition, all TC scholarship is concerned (directly or indirectly) with encountering the unknown. In offering meaningful explanation for the interval of confusion and uncertainty that is inescapably engendered by such encounters, a reflectiveness / defensiveness framework illuminates connections and an element of commonality among all TC scholarship.

Informing Future Theoretical and Application Development

Owing to its relevance for all TC scholarship, a reflectiveness/defensiveness conceptual framework (comprising the proposed theoretical foundation) forms infrastructure on which developing TC theory can be anchored. It also enables issues of learning discipline-specific scholarship to be brought more sharply into focus, clarifying relevant questions. The consequences of reflectiveness or defensiveness, learning – or not, provide an embedding context to contain, shape, and evaluate both developing theory and application.

Defining an Explanatory Theory

The reflectiveness/defensiveness conceptual framework, together with elements of its explication and of its generative phenomenon, form an explanatory theory for student experience, as described in the next section.

A DEFINED EXPLANATORY THEORY: CONSIDERATION OF ROLES

In this section, the explanatory theory defined by the proposed theoretical foundation is considered in light of the roles a TC explanatory theory should play.

Understanding Student Experience: Authenticity / Inauthenticity

In phenomenological terms, Segal is examining elements in the realm of the taken-for-granted unseen, and their transition to a realm of the (seen) explicit, i.e., the development of new phenomenological awareness. Such an orientation relegates discipline content to the sidelines. It thus reduces the complexity – but not the sophistication – of conceptually framing the investigation into student experience. Analysis founded in a reflectiveness/defensiveness conceptual construct becomes a tool for investigating what occurs outside awareness.

One view from psychology holds that defensiveness arises from an individual's inadequacy to manage a situation, and the inadequacy dictates that individual's decisions. Heidegger's phenomenology frames the situation differently: [He] calls defensive responses to rupture *inauthenticity* (Segal 1999 p. 87). Student feedback data from the case study course provides compelling evidence that what I call the *will to authenticity* – an inclination to address the real problem and not be deflected by one's anxiety at doing so – can exert great influence, even in the face of significant difficulty. Consider this student's end-of-term excerpted interview:

(S_m107): [The course appears] very different [to me at the end than at the beginning or middle] ... I'm understanding it better at the end. ... the importance of it is making more sense to me, ... how important it is to have a rational design process. I think if [developers of real software used this approach], the failure rate would not be so high. They'd know exactly where to ... look for [the source of a] problem. I never thought of software that way before. It's fatal: not just with lives (it can be), it also can be fatal economically. ... After realizing it's not just about [code in a particular computer language], I actually went back to the [first design document] – because I didn't understand it; then the [next design document, in order to understand the decomposition of functionality] and what changes might occur, to be prepared for. Second, [I turned to] the [next design document], thinking about procedures (I hadn't thought ... about procedures before realizing it's not just about [code in a particular computer language]), what it does, how to do it. ... I had to keep going back again and again. ... It took awhile for me to get it, I kept talking about [code in a particular computer language] instead of [procedures] with team mates. It was frustrating and difficult. ... [Before I could finish the project], first I had to understand it [my]self. It took 2 weeks; I looked at it each day, and talked with [a team mate] often.

An 'inadequacy/adequacy' frame and an 'inauthenticity/will to authenticity' frame stand in sharp contrast. The former doesn't explain the student's comments, or suggest any way to cultivate similar experience in others. The latter explains the comments perfectly, and indicates possibilities for subsequent teaching through examination of what motivated this student.

Strategies for Teaching: The Importance of Experiential Learning

As the mechanism of transformative learning, reflectiveness is required for productively navigating the interval of confusion that follows an encounter with the existentially unfamiliar. Significant difficulties attach to teaching and cultivating authentic reflectiveness (Boud & Walker 1998), which involves becoming aware of one's habitual behavior. Citing Nietzsche, Segal notes that if self-observation is done by rote, it leads to confusion rather than insight. '*Never to observe in order to observe. That gives a false perspective, leads to squinting and something false and exaggerated. ... One must not eye oneself while having an experience; else the eye becomes an evil eye.*' ... [A] dogmatic commitment to observation produces a disengaged and decontextualised relationship to one's practice (Segal 1999 p. 75, Nietzsche 1974). Reflectiveness must come from a student's internal process, as questioning arises out of her dynamic engagement with the content. It cannot be taught in an explicit or linear fashion, experiential learning plays an important role.

Furthering Discourse

Refining the definition of threshold concepts. Currently, no consensus exists on an intellectually rigorous, definitive criteria for identifying tc's. In clarifying how to specify a threshold concept and how to identify the learning that leads to understanding it, a distinction should be drawn between deep cumulative learning and transformative learning. In terms of phenomenological awareness: In the former, the object upon which one's mental activity is concentrated does not change; rather, one moves one's attention with ease among a multiplicity of its aspects (some previously unattended to). In the latter, one's mental activity comes to be concentrated upon a previously unknown and existentially unfamiliar object.

The two can also be distinguished conceptually using Gurwitsch's fields of consciousness: As a result of deep cumulative learning, one switches dynamically – within the same field of consciousness – among thematic foci, with correspondent restructuring of thematic fields (Booth 1997 p. 144). The total set of elements in the field remains constant, while boundaries among the thematic foci, the thematic field, and the margin become fluid; and component elements shift between adjacent domains. The mechanism of dynamic switching among extant elements corresponds to *reflection*; the operation corresponds to refinement and clarification of one's extant meaning frame.

As a result of transformative learning, in contrast, the contents of the field of consciousness change. Elements formerly not found in any domain of consciousness, possibly including component parts of elements formerly classified as non-decomposable, now occupy the thematic focus or reside in the thematic field; and some elements formerly found there are now relegated to the margin. The mechanism remains mysterious and corresponds to *reflectiveness*; the operation, which results in a different population in the field of consciousness, corresponds to reformulation of one's meaning frame.

With this distinction, one can now formulate a question regarding the designation of tc's: Should the term be restricted to content that requires transformative learning (through reflectiveness), or should it also encompass content that depends on deep cumulative learning (through reflection)? Meyer and Land's tc-defining characteristics suggest the former, wherein new meaning arises to be imposed upon (i.e., a reformulated set of expectations, assumptions, and world model are applied to interpret) both old and new experience. However, the papers presented at both conferences suggest the latter, wherein old meaning is imposed upon (i.e., one's extant expectations are applied to interpret) new experience (Mezirow 1991 p. 11). By clarifying the difference, the proposed theoretical foundation brings this question into focus – and into the discourse.

Refining representation of liminality. For Meyer and Land, the ontological shift associated with liminality appears to denote externally defined change (Meyer & Land 2005 p. 376). Following Turner's metaphor (Turner 1969), they focus on *identity transformation* as altered status or place of self within a fixed world. Liminality is understood to be experienced individually, while it is also treated as an entity unto itself: one enters into and exits from a pre-existing – and persisting – liminal space as one's identity and one's place are transformed in the pre-existing – and persisting – world. Students are cast as an exotic other to be placed under anthropological observation. This representation of the encounter and its aftermath rests on *knowing*; it is organized around the principle of presentation of self to the unknown.

I propose instead a phenomenological analysis of a universal human pattern that happens (outside awareness) during encounter with and response to the unknown. Continuity of one's self is preserved; change, if it occurs, appears to occur in the world. Students are immersed in confusion and experience reflectiveness or defensiveness (liminality). This representation of the encounter and its aftermath rests on *meaning*; it is organized around the process of meaning-making, of interpreting the existentially unfamiliar, the principle of presentation of the unknown to oneself.

The phenomenological analysis conforms to student feedback data from the case study course (Schwartzman 2008). It is also supported by an interesting mix of literature; and makes available more nuanced and more wide-ranging interpretation of student experience, and thus greater opportunity for intervention and support of student learning: In Gurwitsch's phenomenological examination of consciousness, he notes that at the moment of solving a problem, one experiences the perceptual field through which one has been confronted with the problem *undergo[ing] reorganization and reconstruction before one's eyes* (Gurwitsch 1964 p. 52). In analyzing scientific discovery, Kuhn writes that *[a]lthough the world does not change with a change of paradigm, the scientist afterward works in a different world* (Kuhn 1996 p. 121).

Separation of Concerns: Definition as Explanation for tc Terms and TC Concepts

In themselves, TC terms of art and tc characteristics enumerated earlier describe but do not explain, and the terminology conflates elements with divergent meanings.

They are redefined here (using a *taxonomy* (Simon 1996) based on the proposed theoretical foundation), to provide both the explanations and the *separation of concerns* (Dijkstra 1972) required for more careful analysis.

TC terms of art:

- *threshold*: a point of rupture in knowing;
- *threshold concept*: existentially unfamiliar (therefore leading to rupture in knowing), educationally critical content of a discipline so fundamental to understanding that it permanently transforms the practitioner’s view;
- *liminality*: a period of unresolved explicitness, in the form of reflectiveness or defensiveness; an observer may have difficulty, in process, identifying which response is occurring;
- *troublesome knowledge*: an anomaly that cannot be avoided, ignored, or made to conform, leading to a rupture in knowing.

tc characteristics: If tc learning corresponds to a reformulated meaning frame, it qualifies as

- *transformative: by definition*;
- *irreversible*: because meaning frames appear to exist only as dynamic entities in operation at an unconscious level, no structural integrity attaches to a former meaning frame and holds it together for later re-use;
- *integrative*: because a new meaning frame, by definition, illuminates *the relations of interdependence ... binding isolated items into a coherent single whole* (Dewey 1991 p. 80);
- *troublesome*: by definition, one experiences as troubling any encounter with the existentially unfamiliar that cannot be ignored, avoided, or made to conform;
- *bounded new concept space*: as the existentially unfamiliar is never exhausted (Dewey notes that it may arise – always unexpectedly – from any source, at any time, in any place), any concept space is limited in scope.

CONCLUSIONS AND FUTURE WORK

I have proposed here a reflectiveness/defensiveness framework as a candidate (discipline-independent) theoretical foundation for Threshold Concepts. It is intended to illuminate connections in the body of existing TC literature and act as an organizing principle out of which the field can continue to emerge in a coherent way. The explanatory theory defined by it extends beyond description, analogy, and metaphor to provide explanation for TC terms of art and tc-associated characteristics. The two, in combination, also suggest additional possibilities for TC practice and for refining discourse within the developing TC community.

In Husserl’s terms, the former constitutes a *conceptual system*, the latter principles of *theoretical explanation*. My exploration and development of the reflectiveness / defensiveness framework continues with the case study course in my discipline. The ultimate usefulness of this framework (in itself) to the developing TC

community of practice and scholarship will be determined by whether faculty in a variety of disciplines find it helpful to employ individually: to observe, analyze, and support students' encounters with the existentially unfamiliar, educationally critical content of their respective fields; and collectively: to provide a common vocabulary and establish a common standard for *evidence* (Rowland 2000) of learning – or not – and the exploration of how to support it.

This candidate (if deemed substantive) will be evaluated through community practice and scholarship. The proposal (in itself) is meant to expand the discourse – perhaps others will be encouraged to offer additional candidate theoretical foundations; all this accruing, one hopes, to the benefit of developing Threshold Concepts theory.

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