Title:

How was it for you? A cross-disciplinary study of 'troublesome knowledge' as identified by undergraduate students and lecturers in Geography, Medical Science and Psychology

Lead proposer: Siobhan MacAndrew (Psychology SC in Scotland)
with
Nicholas Spedding (GEES), University of Aberdeen
Susan Jamieson, MEDEV, University of Glasgow

Institution:
Host: University of Abertay Dundee

Address: Division of Psychology
School of Social and Health Sciences
University of Abertay
Dundee
DD1 4HJ

Phone:
01382 - 308582

Fax:
n/a

Email:
s.macandrew@abertay.ac.uk

Contents

How was it for you? A cross-disciplinary study of 'troublesome knowledge' as identified by undergraduate students and lecturers in Geography, Medical Science and Psychology

Summary

We carried out a small scale pilot study to determine whether participants would spontaneously identify Threshold Concepts (TC's) and/or troublesome knowledge during open questioning on the characteristics of their disciplines. Students and lecturers reflected upon both easy and difficult aspects of their studies or teaching practice in either group discussions or one-to-one interviews. We compared students and staff observations both within and between the disciplines we examined (Geography, Medical Sciences and Psychology undergraduate degrees). Our intention was to provide specific examples of TC's within our three disciplines to inform further discussion of embedding the enhancement theme both in our practice and in the learning experiences of our students.

Our working hypothesis was that if TC's exerted an influence on the teaching and learning experience either negatively or otherwise, then we would find ample evidence supplied in our interviews. What we found was that overwhelmingly our interviewees focussed on generic skills-based aspects of teaching and learning. Only three potential content-specific TC's were offered spontaneously by students and these were all from the discipline of geography.

What follows is a description of our results and some reflections on what they might mean for future investigations within the context of our subject areas.

Introduction to Threshold Concepts

At the outset, shall we adopt the time-honoured practice of our undergraduates and consult Google for our definition of the Threshold Concept? Doing so produces 4,530,000 results. Moving, as all diligent undergraduates will, to Wikipedia we find threshold concepts (hereafter TC's) are

"core concepts that once understood, transform perception of a given subject"

As academics, however, we have the imperative to adopt a deeper approach to Meyer and Land's (2003) proposition. Indeed not only ought we to engage with the notion, we should also consider what TC's mean for our everyday teaching lives and then turn our considerations into actions.

Meyer and Land proposed and anatomised TC's in the following way. Generically, TC's should have the following characteristics

• *They should be transformative* and revolutionise a student's insight into their discipline and in some cases their own identity

• *They should be irreversible* such that once apprehended the learner does not regress to their previous degree of understanding

• *They should be integrative* and expose inter-relatedness of aspects of the discipline that were previously seen as discrete

• *They may be bounded.* This notion in itself is troublesome given it appears to contradict integration, but Meyer and Land describe the bounded nature of TC's in that they define the boundaries between concepts perhaps even to the extent of establishing the demarcation between different disciplines.

Overall, Meyer and Land summarise the effect of a TC to be that it is *troublesome* (see also Cousin 2006a and b, 2007, 2008).

There is an interesting controversy about the extent to which generic principles for teaching and learning are sufficient. Clearly there are aspects of teaching and learning in HE that are common to all subjects. Therefore training of new lecturers involves pedagogical principles that are vital whatever they are teaching. However this approach does not sit well with those who feel there is 'something special' about their particular subject that requires skills and competencies over and above the '*merely* generic'. Subject centre representatives and educational developers frequently debate this very topic at HEA meetings (eg MacDonald-Ross, 2007). To address the issues there has been considerable effort expended in defining subject-specific TC's and in embedding them within the teaching practice and learning experience. The disciplines at the forefront of empirical work in this enterprise are listed below.

Empirical studies of TC's

Computer Science

Flanagan & Smith (2008)

Zander et al. (2008)

Shiners-Kennedy (2008)

Baillie & Johnson, (2008)

Engineering

Carstensen& Bernhard (2008)

Economics

Shanahan, Foster and Meyer (2008)

Ashwin (2008)

Biology

Taylor (2006, 2008)

Yip (1998)

McCune & Hounsell (2005)

Languages

Orsini-Jones (2008)

Design

Osmond, Turner & Land (2008)

Learning in Professions Allied to Medicine

Clouder (2005)

Fessey (2002)

Rationale for cross discipline examination of Threshold Concepts

A potentially fruitful way of identifying TC's is to undertake cross disciplinary research, in the same vein as Taylor, 2006. However, whereas Taylor studied a variety of biological disciplines, we sought to compare three quite disparate disciplines: geography, medical science and psychology .Our aim was to explore whether the generic view captures TC's more effectively that a subject-specific one. Moreover, we hypothesised that if staff and students from these disparate disciplines identified common TC's, these were less likely to be content-specific, and more likely to be skills-based obstacles to learning and

teaching. . There are or little or no previous data from students or staff in our disciplines and none on comparisons between them.

We now turn to discussion of underlying principles of TC's within the disciplines our team represent.

Within-discipline considerations of TC

The notion of Threshold Concepts in Geography

Dr Nicholas Spedding

Inspired by the work of Meyer and Land, and preceded by a short, introductory piece by Bradbeer (2005), threshold concepts achieved prominence as a pedagogical issue when selected by GEES (the Higher Education Academy's subject centre for **G**eography, **E**arth and **E**nvironmental **S**ciences) as the theme of its 2006 annual conference. The proceedings of this conference were subsequently published as a special edition of the journal *Planet* (issue 17, December 2006).[1]

Threshold concepts are those aspects of education that students find most difficult, but, once these obstacles are overcome, students are able to make major progress. The literature works with the promise of "irreversible", "integrative" and genuinely "transformative" change, supported by powerful metaphors such as the "aha! moment", or the successful traverse of "liminal space" rewarded with "mastery" of the subject (Cousins, 2006). Hence the attraction – to 'crack' the problem of threshold concepts is to revolutionise the student's learning 'journey' – and the enthusiastic response to GEES's initiative. That said, it was also evident that this was not to be a straightforward task, as is highlighted by the link often made between threshold concepts and 'troublesome knowledge.' Troublesome knowledge confronts students with material that is counter-intuitive, not in the sense that it is paradoxical or fantastical, but in that it requires students to reject what was familiar to embrace what is (implicitly, if not explicitly) a more powerful way of understanding their subject. The obstacle is not just defined by technical difficulty: troublesome knowledge as presented by pedagogical researchers, represents an entirely different ("alien") way of thinking that is self-evident ("tacit") to established experts, but not so to undergraduate students. Students must 'let go' of their prior knowledge, often acquired as part of their school education: e.g., in physics or chemistry, over-simplified models of atomic

[1] Available online at: http://www.gees.ac.uk/pubs/planet/index.htm#P17 [Accessed 28 July 2011]

structure (Park and Light, 2009). The new way of thinking and doing becomes second nature (cf. metacognition) as the student steps-up to full membership of the academic community.

insert figure 1 about here

The emphasis given to disciplinary identity by threshold concepts and troublesome knowledge is important and appealing, but it is also potentially problematic. Perkins adopted the term *episteme*, defined as "a system of ideas or way of understanding that allows us to establish knowledge, manners of justifying, explaining, solving problems, conducting enquiries, and designing and validating various kinds of products or outcomes' (Perkins 2006, p. 42, cited by Slinger, 2011). However, academic geographers, following Thomas Kuhn and their discipline's historiographical conventions, are perhaps more likely to speak of 'paradigms' – and, such is the diversity of geography as a "contested enterprise" (Livingstone, 1992; QAA, 2007), this immediately suggests difficulties in identification and application of key concepts. Participants at the 2006 GEES conference identified a huge range of things as threshold concepts: the list published in Planet[2] includes over 100 items (albeit with some duplication). This was perhaps indicative not so much of a "stuffed curriculum" (cf. Cousins, 2006; Stokes *et al.*, 2007), as the diversity of the GEES disciplines, and the flexibility with which participants, most of whom, as 'chalkface' practitioners, had limited expertise in educational development, interpreted the idea of threshold concepts.

Despite this variety of response, some order did emerge, with six key areas identified (King, 2006):

- Quantification;
- Time;
- Knowledge, evidence, complexity and uncertainty;
- Spatial literacy;
- Interdisciplinarity;
- Sustainability and globalisation.

[2] http://www.gees.ac.uk/pubs/planet/p17/tcideas.pdf

As part of a later, independent project on 'Thinking & Learning in the Geosciences', a panel of North American experts identified a similar list, with an implicit emphasis on threshold concepts (Kastens *et al.,* 2009):

- Thinking about time;
- Understanding the earth as a complex and complicated system;
- Learning in the field;
- Spatial thinking.

At one level, the similarities suggest that academics (if not necessarily their students!) hold to strong ideas of disciplinary essentialism/exceptionalism that translate directly into higher education (cf. Clifford et al., 2009). This perhaps gives a false impression of coherence. For example, problems associated with time range from the relatively trivial (memorising the correct order of the periods in the geological timescale), to the mind-boggling (grasping just how 'deep' 'deep time is),[3] to the sophisticated details of explanatory narrative (the impact and implications of different formative, sometimes catastrophic, events that operate at various magnitudes and frequencies). Similarly, spatial literacy is difficult to pin down. It can cover basic skills of map interpretation (still a traditional aspect of high school geography), competence in the use of geospatial technologies (e.g., the technical properties of GIS data models: Srivastava, 2011), spatial reasoning about relationships of objects and/or processes (e.g., how a flat map represents complex three-dimensional rock structures), or alternative 'relational' readings of geographical space as a fluid socio-spatial construct (e.g., Thrift, 2009; see also Slinger, 2011) that defiantly draw on nontechnical, non-positivist traditions. This diversity raises questions about the practical utility of threshold concepts: just which nut should we seek to crack?

Perhaps surprisingly, this initial enthusiasm for threshold concepts and troublesome knowledge was not sustained outside of the threshold concepts 'industry' itself. Specialist conferences continued (e.g., King, 2008); some work went on to raise awareness (e.g., Stokes et al., 2007); the ideas were incorporated into the Geographical Association's review of *The Power and Future of Geography in Schools* (2005)... but little specific work has appeared. That of Srivastava (2010), Slinger (2011), and Hall (2011; from a PhD on climate change and scientific uncertainty) is an exception: threshold concepts and troublesome

[3] Toilet rolls can help here: James and Clark (2006).

knowledge as *explicit* topics have all but disappeared from *Planet* and the USA's National Association of Geoscience Teacher's *Journal of Geoscience Education*, and do not figure at all in the *Journal of Geography in Higher Education*. The chapter dedicated to threshold concepts in the new third edition of Kneale's subject-specific study skills guide (Kneale, 2011) represents something of a renaissance, notable also for its focus on the views of students, not academics. This prepares students to encounter "difficult things" and so contributes to the important task of managing student expectations, but, as with previous discussions, tends to stress variety rather than target specific problems and solutions.

This subsequent failure to develop work perhaps indicates that threshold concepts are less distinctive, or resistant to incorporation by other pedagogic ideas, than their chief proponents might like to think. Indeed, Riley (2006), writing in the special edition of Planet, argued that threshold concepts do not exist as such, but are models used to structure understanding of our discipline, and its associated learning processes and experiences. As a social construct, threshold concepts are inevitably flexible, which is both strength and weakness. If something can be anything that you want it to be, just how valuable or innovative is it? Despite their fruitfulness as ways of thinking about obstacles to student learning, the suspicion remains that threshold concepts and troublesome knowledge are motivated by fashion (postmodern social science? complexity science?), utilising metaphors and analogies (intellectual impostures?) that perhaps owe as much to fancy as to genuine student experience.

Bradbeer (2006) in describing threshold concepts as "elusive and contested" (p. 16) contributes further to arguments that challenge claims to distinctiveness, He draws on Perkins' proactive conception of knowledge to suggest that the crucial threshold involves acquisition of ↺ "particular learning disposition... [in which the learner must be] open-minded, curious, concerned with evidence, to be alert and engaged and willing to venture beyond the comfortable and the known" (p. 16). Such a disposition, or demeanour, is not necessarily associated with any discipline-specific concepts, but it does resonate with other, ongoing debates about desirable student qualities (such as the promotion of 'deep' over 'surface' learning), employability (e.g., GEES, no date) and graduate attributes (e.g., Whalley et al., 2011; c.f. Johnston, 1977) – as reflected in wider, cross-disciplinary initiatives such as the Scottish higher education

Enhancement Themes.[4] It is arguable that, as these have become more prominent, the specific niche once occupied by threshold concepts and troublesome knowledge has been swamped.

The notion of Threshold Concepts in Medical Science

Dr. Susan Jamieson

Medical science is defined here as those biological and clinical sciences that relate to the practice of clinical professions (with a particular focus on medicine, given this author's professional context). In fact, TC's and troublesome knowledge are not themselves concepts that seem to have been widely taken up by the medical science or medical communities – at least in terms of empirical research on undergraduate teaching and learning, published in (bio/medical) education literature – although an empirical study is currently underway at this author's institution (Meek, 2011, personal communication). In the field of medical education, Kneebone (2009) has drawn on the theory of TC's and troublesome knowledge to argue for a new conceptualisation of simulation (the use of models and actors to help students learn procedural skills). Readers from the postgraduate, dental and other health professional communities are referred to an online resource by University College London (http://www.ee.ucl.ac.uk/~mflanaga/thresholds.html#hc; accessed 27th August 2011), which identifies a small number of publications relating to threshold concepts in dental education, postgraduate training (especially surgical), mental health, nursing, occupational health and physiotherapy.

Content-specific threshold concepts in the medical sciences

Medical sciences would include such disciplines as physiology, neurobiology, biochemistry, molecular biology, cell biology, genetics, pharmacology, and others besides. Various authors (Meyers and Land 2003, 2005; Taylor, 2006; LeBard et al, 2007) have identified content-specific TC's in, or relevant to, one or more of the medical sciences. In a cross-disciplinary exploration, Meyers and Land (2005, p.374) describe a conversation with a physiologist in a London medical school who proposed that 'pain' is a content-soecific TC in medicine, or rather, the transition from perceiving pain "as something negative", to understanding it is "an ally that aids diagnosis and healing". Meyers and Land (2003, p.8) cite a personal communication with Sproull (2002), who proposed that 'metabolism' functions as a TC in exercise physiology – in particular the integration of theoretical knowledge with activities and practices.

[4] See, for *Employability*: http://www.enhancementthemes.ac.uk/themes/Employability/default.asp and, for *Graduates for the 21st Century*: Integrating the Enhancement Themes: http://www.enhancementthemes.ac.uk/themes/21stCGraduates/default.asp

Taylor (2006) interviewed seven academics from four institutions from the UK and Australia. The participants were from the broad spectrum of biological sciences, but the relevance to medical science is clear. Taylor described (p.88) how TC's with a "common ancestry" emerged from discussions between teachers from different biological disciplines, when they compared areas of conceptual difficulty within their discipline; thus 'osmosis' (movement of water) was identified as a content-specific TC that applies to such diverse disciplines as neurobiology, biophysics and agricultural botany. TC's with a common ancestry illustrate the "inter-relatedness of all aspects of biology" (Taylor, 2006, p.88). Other cross-disciplinary discussions within biology identified putative content-specific TC's relevant to medical science, including "the consequences of meiosis" and "the stability and continuity of DNA molecules" (*ibid*., p.89).

Generic threshold concepts in the medical sciences

Taylor (2006) identified several threshold concepts that were not to do with discipline-specific content *per se*, but were generic concepts that proved troublesome for learners across the biological disciplines:

Probability

Uncertainty'

Variability

Change

Complexity of living organisms

Link-building

Understanding processes

Scale

Language of science

Hypothesis creation

Are these TC's relevant to medical science, or to medicine(the profession to which the medical science students in this study aspire)?. Many of these generic TC's require the learner to be comfortable with a lack of predictability, a notion with which many students struggle. Nevertheless, a firm grasp of such

generic TC's is essential for clinicians. For example, in treating patients they will need to take into account probabilities of different clinical outcomes, or uncertainty of prognosis. As medical scientists *per se*, they will need to practise hypothesis creation. As learners, in recognition of the complexity of living organisms, students will constantly need to review and refine (change) their understanding of scientific concepts, to arrive at more sophisticated understandings.

Regarding link-building (or mapping - see earlier), if students cannot achieve this they will not *reach* that sophisticated, 'big picture' level of understanding and their 'learning' will leave them with isolated "islands of knowledge" (Taylor, 2006, p.89).

Taylor (2006, p.90) found that "troublesome knowledge appeared to be associated very much with *processes* [sic] in biology". In a study where students rated the relevance of topics to their degree and answered open-ended questions about problematic areas, LeBard et al (2007, p.75) found that second year molecular biology students struggled with complex biological processes such as "gene regulation, transcription and translation". Taylor (2006) suggested that students' difficulties in learning about processes may reflect the constant revision and movement towards increased sophistication of understanding inherent in the learning of biology; and/or the way in which biology is taught in the early undergraduate years – didactic transmission of facts, as opposed to an approach based on teaching broad concepts; and/or the fact that many biological processes are submicroscopic and the concepts to be learned are so abstract.

With regard to scale, Taylor (2006, p.94) noted that a recurring theme amongst her participants was that "objects or processes which cannot be viewed directly prove much more difficult to teach and to understand" – participants gave examples relating to subcellular function and to biochemistry – both pertinent to medical sciences.

Meyers and Land (2005, p.375) proposed that the learner adopts an "extended discourse", which is to say that they engage with and become conversant in the language of their specific community of practice. LeBard et al (2007) found that molecular biology students "struggled with the number of definitions and the number of 'parts' and were overwhelmed with information". Some students responded by rote-learning. In medical sciences, learners need to acquire and utilise a scientific vocabulary. Moreover, this difficulty is compounded by the fact that to apply their scientific learning in a clinical context, and to function in their future profession, students of medical sciences also need to engage with the language of medicine.

LeBard et al (2007) also identified 'numeracy' as a troublesome area for second year students – mostly medical undergraduates - undertaking a statistics course (Quality of Medical Practice). LeBard discussed the possibility that students found it difficult to engage with the topic, even though they saw its relevance to their degree/career. It's also possible that difficulties with statistics relate to a failure to grasp the TC of 'probability'.

Threshold concepts relating to 'positioning of self'

Meyer and Land (2005, p.375) developed their theory of TC's to propose that these have a *reconstitutive* effect, which is to say that acquisition of TC's leads to a transformation in the learner's identity, a "repositioning of the self" (*ibid*., p.374). In the action research described in this article, the students of medical sciences are medical undergraduates who have spent their early years following the medical curriculum. One area of interest will be whether encountering and grasping TC's in medical sciences impacts on their sense of identity as medical scientists, or as future clinicians.

Implications for teaching in the medical sciences

The studies described above indicate that teachers in medical sciences need to design activities to help their students understand complex, abstract biological processes. Ross and Tronson (2007) described various creative activities designed to help first year students grasp difficult biological concepts. Activities included model making (e.g., a 3D cell from Playdough) and role-play (dances to illustrate glycolysis and Kreb's Cycle). Evaluation suggested these activities helped students to understand "abstract (submicroscopic) concepts in biology".

Meyer and Land (2005, p.377) advocate the use of, e.g., support materials, technologies, mentoring and peer collaboration to help students move beyond the liminal state. Teachers also need to be aware that students will "cross their own threshold at different times" Taylor (2006, p.92) Taylor continues:

> "The role of the teacher … becomes one of presenting a series of carefully crafted challenges, which will facilitate these moves [across thresholds] and are presented at appropriate times"

Finally, medical science teachers also need to help students make links between seemingly disparate 'islands of knowledge'.

A further area of interest in the study described in this article is therefore the extent to which the teachers interviewed have adopted any of the strategies described above, consciously or otherwise. Or whether they have developed novel strageiesfor helping to promote their students' learning of content-specific or generic TC's.

The notion of Threshold Concepts in Psychology

Dr Siobhan MacAndrew

Consider the content of the contemporary discipline of Psychology. It grew from philosophy of mind, phenomenology (emphasising the role of subjective experience) and epistemology (instructed by 'the *nature of knowledge'* and how things can be '*known*') and those roots are still clearly discernable in our research on cognition, consciousness and human behaviour. Given the scope and aim of the discipline one might expect that it might have something to tell us about those aspects of understanding that prove troublesome or transformative to undergraduates. However the discipline itself is so divers (as is the case with geography and medical science) that experts in each field within the greater discipline would argue for fundamentally different TC's. Indeed many psychologists argue that the gap between their research subject and that of other colleagues is so large that it results in a different discipline altogether (compare for example neuroscience and social psychology). What's more, even with the psychologists' understanding of how the mind works, discussion or identification of TC's in the subject has not occurred.

Why is this? One possibility is that reflecting on human thought is so central to thinking like a psychologist that there has not been a need to reify the notion. In other words the idea of TC's is self evident in our subject area in how we teach and in how our students learn. As a result there are no empirical studies of TC's as identified by students or staff in psychology.

However that does not mean that the discipline does not provide a useful account of concept acquisition, concept development and knowledge structures. Psychological research speaks not only to learning in our discipline but to every other. With that in mind (both literally and metaphorically) what can psychology tell us about troublesome knowledge in students' learning and lecturers' teaching?

Conceptual development and cognitive change

We might find some interesting insights into student learning by examining developmental psychology. Carey and Spelke (1998) provide an intriguing comparison of the conceptual development of the child and concept development in the scientist. Their general conclusion is that the child resembles the scientist in terms of beginning with separate, discrete concepts and gradually recognising links between them - a process known as 'mapping'. In particular, in both problem solving and conceptual change children use 'analogical mapping'. This means they make links between concepts on the basis of their similarities and differences. For instance, initially they base their understanding of animals on their understanding of the characteristics of people. Indeed Carey and Spelke argue that the later more sophisticated and correct characterisation of animals versus humans actually *emerges* from learning about people. Furthermore they suggest that to understand the processes of scientific revolution we might begin by observing the infant's journey from experience to integrated knowledge structures. In terms of this report we may also observe how frequently as educators we emphasise 'making links' in both our research activity and in our teaching.

In early cognitive development Carey and Spelke identify 'core systems of knowledge' inherent in individuals and look at the impact upon these of gradual accretion and enrichment of knowledge versus abrupt conceptual change. Applying the foregoing to TC's in learning we might imagine our students begin with a set of basic literacy and numeracy skills (core knowledge), learn a series of facts of increasing difficulty (accretion and enrichment) and hopefully experience transformational conceptual change en route to expertise. But do all of these components have equal weight? do they follow one another sequentially? and do students necessarily attain that final transformative event? All the questions suggest fruitful paths for future research.

A conceptual change for Carey and Spelke for both the infant and the scientist would be one where

> 'core concepts in the new theory (T2) cannot be expressed in terms of the old theory (T1).'
> (Carey and Spelke, 1998, pp253.

A description that sounds very similar to our notion of TC's.

Turning to the impact of instruction, there is debate about the extent to which explicitly taught knowledge brings about conceptual change during cognitive development. Some theorists argue that such transformations happen spontaneously and the emergent principles 'carve the world at different joints' (Carey and Spelke, cited in Goswami, 2008).

Suppose true conceptual change in our students is an 'emergent property' of the accretion and elaboration of their knowledge? what does that mean for our teaching practice? At first sight it seems a policy of despair since beyond providing a good learning environment we cannot influence the intellectual process of our students. However, as will be seen in our interviews, not only do we succeed in this, but our students recognise *our* role in providing a good learning environment and *their* role in carrying out the learning or as I have suggested here 'conceptual change'.

Metacognitive insight in learning

A fundamental notion in cognitive psychology is that of 'metacognitive awareness' (for a review related to education see Veenman, Van-Hout Walters and Afflerbach, 2006). Put simply, this refers to our ability to reflect upon our own mental processes. Acquisition of this ability is crucial in the cognitive development of the infant. Subsequent maturation and experience continue to enhance this awareness as we age. We could see metacognition as our window into how our minds are working and the process we examine when we suspect something intellectual is amiss both within ourselves and within our students. Indeed I would argue that during an effective assessment we are probing a student's metacognition and not just their memory for facts.

In the lab we distinguish between automatic cognitive processes, which are fast, not under conscious control and not accessible to conscious access (such as many processes in word recognition and reading), and those that are deliberative, slower, under conscious control and amenable to articulation (such as offering a word in response to a definition, or describing how you solve a logic problem). In other words we are 'in charge' of deliberative mental processes to the extent of making decisions about how and when we perform them and being able to describe and comment upon them. Thus we have metacognitive awareness for those processes that are deliberative and not for those that are automatic. If we seek to intervene positively in the mental processes of our students and the content of their minds then we focus upon aspects of their thinking to which they have conscious access and upon which they can comment. (for a full review of deliberative processes see Harley, Jessiman & MacAndrew ***)

It should be noted that Biggs uses the term 'metacognitive awareness' as synonymous with 'metalearning' (Maudsley, 1979; Biggs 1985). Whereas the psychologist uses the term metacognition to refer to insight into cognitive processes in general, Biggs is referring to learning skills alone. Metalearning refers to the student's progression to effective understanding and control of their own idiosyncratic learning aptitudes and skills. (see Meyer, Ward & Latreille, 2009; Ward & Meyer, 2010). We might

wonder, then, if as educators we exert our influence at the level of metacognition - what we might consider the training of the mind - or metalearning - what we might think of as training for learning.

Allan and Clarke (2007) employed focus groups to examine metalearning in a group of first year students enrolled on a 'Learning for Success' module, which was not discipline specific. In the module students explored different approaches to teaching and learning and analysed their own study skills. The students commented that they had 'changed as a person' as a result of reflecting on the strengths and weaknesses of their past approaches to study. These findings reiterate that in the students' opinion their increasing abilities in learning skills has more of an intellectually transformative effect than accruing subject specific knowledge. Students focussed on the value of the 'how' of learning rather than the 'what' of learning. Importantly, Isaacson and Fujita (2006) provide data that show that facility in metalearning predicts academic success (but see also Sternberg, 1990). For an overall review of metacognition in education see Hacker, Dunlosky, & Graesser (2009).

Metacognitive insight in teaching

Thus far we have concentrated on the mental processes and representations inherent in students' access to learning in general and TC's in particular. Now let us turn to lecturers. We might suppose that an effective lecturer would be someone who as an undergraduate had navigated the TC's of their discipline successfully. Is this the case? If we consider what we have already said about students, it may be that appreciation of the TC's is implicit and not immediately available for articulation. This suggestion might account for the old chestnut of the gifted researcher who is not a successful lecturer. It may also be true that just because you are good at something you may not necessarily know *why* you are good and consequently be able to impart this to others. A final and more optimistic possibility is that experts in fields have had the time to reflect on what made them successful learners in their disciplines and concluded that as with students it is the 'how' and not the 'what' that matters. Intriguingly Canon-Bowers and Salas (2001) suggest that teams (here student-lecturer communications) work best where they have a set of 'shared cognitions' which they take as common knowledge and therefore do not specifically refer to. Perhaps both students and lecturers see the subject content as common ground and focus on the differences between themselves as educators and students - that is, their differing levels of expertise in learning itself.

Method

We adopted an 'action research' approach and make no claims for the scientific validity or generalisability of our findings. Rather we see our project as a body of material to facilitate later more controlled studies.

Our interviewees were third or fourth year undergraduate students and staff in Geography, Medical Sciences and Psychology. We asked them a set of open questions (see Appendix 1) concerning aspects of their discipline they found easy or difficult. Notice that we did not lead them specifically to a discussion of discipline content *per se*. The interviews were extremely informal and paced by the interviewee in terms of duration and how much they said in each reply. Participants received a book token in recognition of their contribution. The participant information sheet and the consent documents required for ethical approval of this study are in Appendix 2.

Subject-specific interpretation of interview findings

Geography

Dr. Nicholas Spedding

One staff member and seven students were interviewed. They are given fictitious names below.

Table 1: Interviews with Geography staff and students

Staff	
George	Senior Lecturer and Senior Adviser of Studies. Teaches students at Levels 1 to 5; in post since 2005, having previously worked as a post-doctoral researcher. Particular expertise in environmental change
Students	
Brigitte	MA Geography-History; entering Senior Honours September 2011
Margaret	BSc Geography-Geoscience, graduated July 2010; now studying MSc Environmental Science
Fred	BSc Geography-Geoscience, graduated July 2011.
Martha	MA Geography-German; entering Senior Honours September 2011
Louise	MA Geography, graduated July 2011
Liesl	MA Geography, graduated July 2011
Kurt	BSc Geography, graduated July 2011

*Staff*George identified little difference in subject content between what was taught at school (albeit A-levels) and what was taught to first year students. He identified changes in the *style* of education as the key transition: persuading students to abandon their deferential attitudes to staff as authority figures and their reliance on being taught the correct material, and encouraging them to develop confidence, independence, and active, inquisitive study habits. George saw the first obstacles in subject content as arising in second year (e.g., unfamiliar equations), although these tend to be closely associated with challenges defined by a step-up in generic skills required – especially in relation to the *Skills and Techniques in Geosciences* course, for which students must complete an original piece of fieldwork research and write it up as a formal academic paper. He believed that students found things such as the requirement to use 'proper' literature (not just textbooks or Google), to identify patterns in data (perhaps using statistical techniques), to synthesise material and to provide a critical analysis of their own findings as the most troublesome. He remarked that second year students "can do essays, but not a report on the

same subject", which supports the argument for thresholds defined by the need to master unfamiliar ways of working rather than by technical, subject-specific concepts.

In contrast, when asked about the most difficult aspects of Honours study, George suggested that it was the philosophy of geography that was hardest. In part, this was because of the subject's diversity: "[you have to] teach everything from physical to cultural, from hard core positivism to softer cultural topics". Technical jargon and the abstract character of this material created important obstacles, as did the absence of a single, 'correct' way to do things: "[You have to] try to get students to see issues are not black and white – and that there are conflicts between different methodologies". He suggested falsification as an example of a threshold concept, which, associated as it is with uncertainty and provisional knowledge, was problematic for students accustomed to truth delivered by the successful application of science,

Students

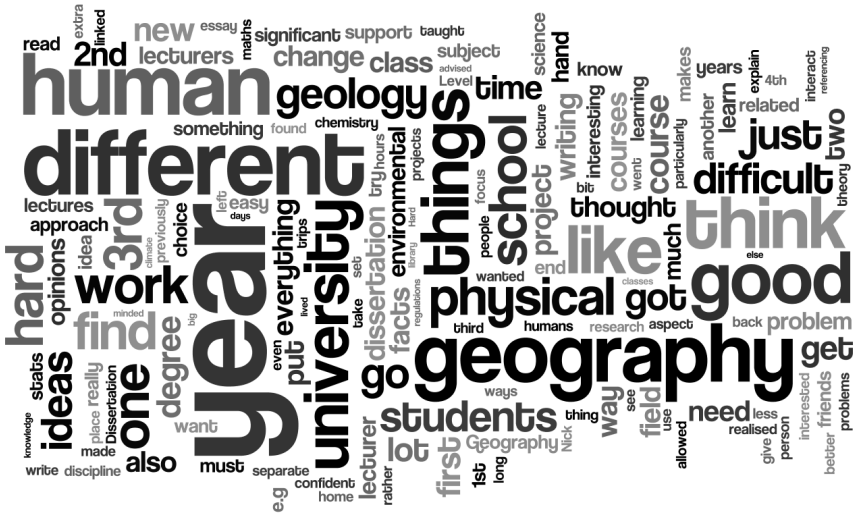


Figure 2: Wordle representation of the student interview transcripts. The prominence of any word in the 'word cloud' is proportional to the frequency with which it appears in the text.

Experience of first year

Students often agreed with George in that they found little that was difficult in the subject content of first year geography, describing it as repetitive or even simplistic. Only Brigitte identified a specific technical obstacle. Asked "what did you find difficult about first year?" she answered:

> "Probably the physical [geography] transition. I thought I was good at it and then it was too mathematical. Different to school where I thought I was good at something and then I found that I liked a different subject."

It is significant that Brigitte was able to 'negotiate' the difficulties later by opting out of physical geography in favour of human geography, although her choice was also inspired by the attraction of new areas of human geography such as the study of place and identity. Conversely, Margaret found human geography difficult, having done less of this at school, which was influential in her choice to specialise in physical geography and geology.

Everyone had found major differences between school and university in the style of learning and teaching. The format and length of lectures was a common theme, as was the pace in which material was introduced. As Kurt said:

> "In comparison to school to see someone else delivering in a lecture setting, the material came across differently. A lecturer uses different analogies – shows different ways for looking at problems... A-level taught it one way – then at university with a different lecturer with a slightly different approach who missed out some of the steps – also went though course very fast – two years of A-level were covered in one term."

Students also agreed on the challenges presented by expectations of independent learning.

> "I had to work under my own steam – lecturers won't spend ages on you. What's hardest to grasp is the teacher teaching versus student learning" (Louise).

Time management, and the demands of juggling various assignments was also identified as difficult. Although asked specifically about their studies, in their replies students often brought up their wider

experience of university. 'Lifestyle;' anxieties about things such as making friends or budgeting figured strongly alongside adjustment to the unfamiliar academic environment:

> "A-level was covered whole in the first year, but I was glad of the extra year. Straight from school where it was intense, it was good to have a year when the workload isn't hard and you can get used to the whole lot – e.g., living away from home, university in general, getting used to work, handing-in, lectures very different to lessons..." (Kurt).

The "aha! moment"?

Kurt spoke of a:

> "'Flashbulb moment'– referencing! I used to write my essay first then find references after. Then I realised if I read everything first before writing it makes essay writing easy…"

but he was the only student who framed progress in such abrupt, revelatory terms. Louise also identified referencing as a threshold, but in a less dramatic, and rather more narrow sense:

> "Referencing was trickiest, as it was very new. I had spent so long not doing it at school, but now must do it. It's hard to work out what facts are common knowledge and so don't need to be referenced and what things must be referenced. If you get it wrong, you feel stupid."

The others obviously recognised progression over the years of study, but did not present this as structured by clearly defined thresholds that had to be overcome. Most agreed that the transition from second to third year was a significant jump, but one that was defined not so much by subject technical content, as by an increase in workload, by additional pressures to take on responsibility and negotiate the choice of courses available, or by greater expectations for students to think for themselves. Several students appreciated that they had improved their ability to handle different ideas, or to make links between different concepts, but this was gradual change as higher level skills were acquired. There was consensus about the 'capstone' nature of the dissertation as something that draws on greater autonomy and enhanced skills, so bringing things together. For example, Margaret identified progressive integration, extending into her Masters course, as a key feature of her studies, and a source of satisfaction:

> "In the first year the two [i.e., physical and human geography] were separate, not linked. When they are separate it's less interesting. I prefer a holistic approach, once I see the linkages, especially now I'm doing an MSc. Projects show the linking. You have a have feeling of growth and progress and understanding more and you put in your own opinions."

> "[When I did my] fourth year dissertation I could see how what I learnt though the degree linked in to the project. You had to put both facts and opinions and all previous research together to give an end result where something was of publishable quality."

Statements such as this do indicate key changes to the ways in which students learn, and how they view their subject. These changes may reasonably be described as, to borrow the terms used by Meyer and Land, transformative, irreversible, integrative, reconstitutive, discursive... but there is little evidence that such progress connects strongly to specific TC's.

Thresholds concepts and troublesome knowledge?

There was little in students' accounts of their studies that matched previous discussions of TC's and troublesome knowledge in geography. Students did identify transformative concepts, but did not always present these as difficult. Perhaps thresholds need not be troublesome? For example, Margaret welcomed the insight into time that her fieldwork provided:

> "Field work was easy; I like hands-on learning. I had done the subject [geology] at school so [first year] was a bit repetitive – but it actually helped and made clearer the different context... how everything relates to each other rather than individual subjects. For instance we looked at Stonehaven rocks. At school we studied individual rock types, we didn't link them – everything was individual. [At University] when we walked along we moved back through time and saw how that layer went on to another, that there were time sequences and then more recent sequences like erosion and glaciation."

Similarly, Louise embraced the possibilities of mathematical and scientific concepts incorporated into geography from other disciplines:

> "I have physics, chemistry and maths students as friends, so I liked systems theory in the geography course. I saw links. I discovered maths and how it can be put into models. Maths looks for the simplest explanation..."

Brigitte, however, found quantitative aspects of her course difficult, which supports previous work (the discipline's stereotypes of itself?) and, indeed, George's ideas. Brigitte explained:

> "Third year was tricky about blending physical and human [geography]. Had stats and that was awful, I'd never done stats before. More than I'm used too. Mix of the two. I had a better grasp on human. Focusing on human and then finding stats difficult. It was more skills than the actual ideas. I understand the concepts but it's how you put them into place."

What is interesting here is how Brigitte presents the requirement to do statistics (as part of the compulsory research design course) as something that is separate from her own favourite aspects of the subject. Statistics are implicitly, if not explicitly, attached to physical geography, whereas Brigitte likes human geography. This appears to rationalise why she finds statistics difficult (i.e., they are not part of her own preferences/area of expertise) – although, from a disciplinary perspective, statistics, albeit indicative of a scientific/positivist approach, are not exclusively associated with physical geography.

George had identified the diversity of geography, and in, particular, the wide range of philosophies and methodologies adopted across the discipline, as problematic, an assumption repeated in Kneale's (2011, p. 33) study skills discussion of threshold concepts. Students did not consistently support this view. Louise did agree that "the diversity of the subject can be confusing..." but went on to say that this was because "I am a person with lots of ideas... I find it hard to focus and I take on so much info and think of ten ideas at once. Geography makes you think about things in different ways and with different perspectives." Indeed, she went on to say that she found geography interesting precisely because "it's so broad – e.g. music, migration, cultural heritage, history, economics... I realised in first year that nothing is stand alone, topics are not independent, there's no way to separate them". Different students found different bits of the subject hard or easy (e.g., Brigitte's dislike of statistics), but the diversity of approaches *per se* did not always raise concerns. If anything, students enjoyed the diversity of the subject, in that it created choice and enabled them to negotiate a personal, selective pathway through the

wider curriculum, playing to personal strengths/preferences and avoiding many of the more troublesome concepts.

It is feasible that thresholds exist, but that students do not identify them. For instance, Fred struggled to produce work that clearly crossed the 2.2/2.1 borderline. He attributed this to harsh marking, suggesting that other subjects such as law did not have such high standards. This is anecdotal evidence, so we cannot discount the possibility that his work was harshly marked, or that standards of achievement do differ between disciplines. But what if the marking was fair? There is an alternative interpretation: i.e., in blaming the 'system' of staff markers and regulations for his failure to do better, Fred arguably fails to recognise the wider qualities (if not specific concepts) that define the 2.1/2.2 threshold: e.g., to paraphrase the geography department's Level 4 mark descriptors that define the 2.1 standard: direct and wide-ranging answer to the task set; value-added to basic lecture and textbook material; use of research literature; obvious critical ability; reasoned and sustained argument, with effective use of supporting evidence. This makes sense; indeed it is what we should expect. Students get certain marks because they do or do not cross certain thresholds, and demonstrate differential performance against key graduate attributes. But from a pedagogical perspective it is worrying if students do not recognise (not just do not cross) such thresholds. It is difficult to overcome an obstacle that you cannot see.

Summary

The interviews provided clear evidence of academic progress. Students agreed that their studies had become more difficult, that their appreciation of the subject had changed over four years, and that they had developed important skills that map onto definitions of graduate attributes (e.g., greater autonomy, critical thinking, improved abilities to synthesise material). "Year", "difficult" and "think" feature strongly in the Wordle word cloud (Figure 2); "2nd" and "3rd" are bigger than "4th", which perhaps supports arguments that students make the key transition in the middle years of their education, using their final year to enjoy the benefits. However, support for 'classic', subject-specific notions of TC's and troublesome knowledge was, at best, mixed. It is possible that the informal, open format of the interviews, conducted in everyday language with limited prompting or attempts to probe students' technical understanding simply did not create conditions appropriate for identification of threshold concepts. Absence of evidence is not necessarily evidence of absence! But if we do take the interview evidence at face value, students' own accounts, in their own words, of their 'journey' through higher education support wider interpretations of

thresholds associated with transformation of disposition or demeanour. As Kneale (2011, p. 33) put it, "learning at university is a threshold concept for most GEES students".

The initial threshold, common to all, was the experience of moving to university. This presented a challenge created by new styles of academic learning combined with wider student lifestyles, but encounters with subject-specific technical difficulties did not figure that strongly here. Students' experience of subject study at school was important as it defined what was, and what was not, in their personal comfort zone. The diversity of geography as a subject was important too, but it is perhaps not as troublesome as might be expected. It can cause problems, but it also provided students with opportunities to avoid perceived obstacles by choosing to specialise in different parts of the subject. It was clear that students had firm individual views, often formed by their school experiences, of likes and dislikes, what was hard for them, and what was not – and these continued to be influential. Note the prominence of "human" and "physical" (and also "geology") in Figure 2. Because of geography's diversity and its status as a 'contested enterprise' without a dominant *episteme* or paradigm, there is perhaps less consensus than in other subjects about which rites of passage should be mandatory. It is both practical and intellectually respectable to opt out of large chunks of academic geography once at university. At the University of Aberdeen, students can start to specialise from Level 2 onwards, and are encouraged to do so if they wish. This implies that, as TC's are mostly absent from the fixed Level 1 curriculum, specific threshold concepts are not that important to geography students. Technical difficulties exist, but student utilise their choice of options, and within-course flexibility (e.g., choice of assessment tasks) to avoid most of these. If so, the absence of universal, unambiguous targets is not helpful to pedagogical practice. Students stressed how much they had valued the support of teaching staff, but this (unsurprising) finding in itself tells us little about how to make thresholds work to the advantage of students.

Medical science

Dr. Susan Jamieson

*The participant*o be consistent with the geography and psychology arms of the study and interview students in their 'final' year (L4) of a Bachelor's degree, and also to 'target' students who would be available on campus rather than in hospital placements, we approached medical students undertaking an intercalated degree in medical sciences. About 25% of the year group at Glasgow Medical School have the opportunity to intercalate after the 3rd year of the MBChB programme. Mostly they take the 1-year

BSc Med Sci programme, although a small number do a 2-year programme leading to a BSc. For reasons of access, the specific students approached were those undertaking the 1-year BSc Med Sci course in Cancer Sciences, or in Clinical Pathology. Ethical approval was granted by the ethics committee of the College of Medical, Veterinary and Life Sciences. Access was via permission of the BSc Med Sci Director and the specific course directors. Four students (of 11) agreed to participate and were interviewed individually. The member of staff was an experienced academic (>25years) who has been teaching intercalating students for many years, as well as graduate students; he is not involved in the delivery of the core MBChB programme, but contributes to specialist options (student-selected components) for students in Year 2 and beyond.

The curriculum

For their first 3 years, students followed Glasgow's post-1996 medical curriculum, which had a substantial component of problem-based learning (PBL). Briefly, working in small groups, students use a paper-based clinical case as a stimulus to identify learning issues and set objectives; after 2 or 3 days of independent research and faculty-run support sessions (lectures, labs), they re-group to share information, discuss their new understanding of the case, and reflect on the process and on their performance. They also participate in a variety of other activities related to acquisition and development of their vocational skills and clinical skills. The intercalated year is similar to the Honours year of a BSc degree: lectures on medical science topics; teaching on research skills and statistics; journal clubs; and a 15-week research project.

Staff

In common with the geography lecturer, the medical science lecturer did not identify much in the way of content-specific TC's, although he did suggest "history and philosophy of science" and elaborated that students "need to [learn to] see science in terms of incremental changes and not a home run".

Rather, he seemed to identify TC's related to generic learning skills or, rather, generic *research* skills, He commented that at an early stage (of the intercalating year) students' "information gathering and critical analysis skills have not developed". Students also had difficulty integrating various aspects of the 'research process' (i.e., generic research skills, including "review of the literature, design, data analysis and writing up".

The lecturer saw his role as helping to build students' confidence and helping them to "learn the rules of the game", by which we presume he means the research process. He suggested lecturers need to understand that the same approach will not work for every student; they need to interact with students; and they need to encourage the student to think for himself.

The lecturer expressed frustration with students' apparent fixation on intended learning outcomes and bemoaned the fact that "they are less interested if something is not examined". This resonates with the views of the Psychology lecturer (below). Staff across the disciplines clearly value generic skills, such as integration of curricular components or content; they need to communicate this to students, and assess suh skills.

Students

The students described their experiences in Years 1-3 of the PBL-based medical curriculum, as well as in their research-oriented intercalating year.

Content-specific troublesome knowledge

Reflecting on their early years in the medical curriculum, students did not explicitly identify content-specific threshold concepts. Student C found the "hierarchy of information" difficult. She may be referring to the 'hierarchy of systems', which is the application of the concept of 'systems thinking' in a medical context, where students are expected to consider clinical problems from different perspectives (at different levels of the hierarchy). E.g., Alzheimer's disease may be considered a molecular problem (abnormal tau protein) or a social problem (caring for increasing numbers of patients with dementia).

Students did identify content-specific troublesome knowledge (in the sense of being difficult-to-acquire, rather than in the sense of counter-intuitive) and even an awareness of *why* this knowledge was troublesome:

> "Difficulty came with 'deeper' science subjects, especially cell [signalling] pathways and neurophysiology. [I] am a very visual learner, so [it's] difficult to picture pathways and much easier to visualise something like the heart and how it works" (student B)

> "[I] found public health modules easy as [this was] basic information and common sense. Found cellular processes difficult …" (student C)

Thus, consistent with the findings of Taylor (2006) and LeBard et al (2007), if content was perceived to be abstract or complex, it proved troublesome. This was not only true in the early years of the medical curriculum, but in the intercalated year, where there was "really dense science at first" (student D).

In fact, as with the geography students, most of the potential threshold concepts were related to generic learning skills or, more specifically, generic research skills. Student C found the intercalated year difficult because she did not know 'how to research'. Statistics was identified as troublesome by student D.

Learning through PBL

A common theme with all 4 participants was that PBL was difficult initially: it was "a shock" (student D). This was true even where they thought it was a "good idea in theory" (student A) and that it was a "great way to learn" (student B). One difficulty may have been the inconsistency of facilitator styles:

> "Some PBL teachers [were] very variable, some involved in what you learn[,] some just there to tell you what to research and learn" (student A)
>
> "Found it difficult working with different facilitators" (student C)

Student D said PBL was difficult because she was "very shy and not confident about getting answers right and speaking in front of class".

Integration: crossing the threshold

Three students identified the "clinical based blocks" (student C) in third year as the point when everything fell into place. It seems the key was application of their knowledge in the professional context:

> "… applying knowledge in clinical settings…" and "… lots of time in hospital cemented information already learnt" (student A)
>
> "Theoretical work and clinical skills were really well matched" (student B)
>
> "[Clinical] placements … changed perspective and allowed you to augment learning at university with learning in the hospital" (student B)

In the intercalated year, student C learned 'how to research' by application of research skills in the context of the research project. It seems, therefore, that contextual application of knowledge, be it in the clinic or at the research bench, helped students to cross thresholds towards becoming clinicians or researchers.

There was some evidence that more creative, interactive teaching sessions helped promote understanding or transformation. For example, student B found that interviews with actors helped her to learn how to deliver bad news to patients. Other examples were workshops in experimental design, during the intercalated year (student B).

Student C commented on the helpfulness of the 'spiral [of] learning', which is the concept of re-visiting topics year-on-year, but at increasing levels of complexity.

Consistent with Meyer and Land's suggestion that peer collaboration may promote students moving beyond the luminal space, student B commented that "talking through problems with coursemates helps".

Meta-learning

Encouragingly, all 4 students interviewed showed evidence of meta-learning.

Student B found that by her final year 'cells' remained difficult but she no longer considered this problematic. This is because she had developed learning strategies: she generally worked harder, but she also "got a Latin book to understand where cell names came from". Thus, she found a strategy to grasp the threshold concept of the language of science (Taylor, 2006). Transformation had taken place, in how she *learned* course content.

Students came to an appreciation that learning was not all about absorbing content:

> "Don't worry about content too much, focus on having a basic understanding of everything" (student A)
>
> "Learn to grasp concepts instead of overloading yourself with information" (student B)
>
> " … do the PBL work thoroughly, summarise it and understand it, do not just memorise it" (student D)

Student D also acknowledged that the "process of monitoring your own learning and understanding [was a] good thing". However, she did qualify this by suggesting that students in first year could get by with memorising and regurgitation, so it would have been beneficial for staff to monitor students' understanding at that stage.

Continuum of learning

Student A would advise incoming students the "get on board with the idea of consistent learning". Student A said that learning became easier in the clinical year, when everything fell into place. However, she then qualified this by saying it "became harder when faced with real patients" (Student A). This is consistent with the idea that students may pass through one threshold (linking scientific and clinical knowledge), then encounter another (dealing with actual patients).

Summary

There was agreement between some findings from this study and those of Taylor (2006) and LeBard et al (2007). Specifically, students in the medical sciences struggle with understanding complex biological processes and abstract, submicroscopic biology.

Lecturers could potentially address this by using creative activities as advocated by Ross and Tronson (2007). For example, using animation to help students understand cell signalling pathways; or even role play to understanding the concept of signal transduction.

Students found it easier to understand troublesome concepts when they were interested in the subject (e.g., pathology) and when they could apply their knowledge in a relevant context. This was true for both clinical practice and scientific research

All student participants in the medical sciences arm of the study engaged with meta-learning. The teacher also had a good grasp of metacognitive aspects of teaching and was more concerned to help students learn '*how*', rather than '*what*'..

Psychology

Dr. Siobhan MacAndrew

Psychology lecturer

The psychology lecturer interviewed was a highly experienced member of staff who had taught psychology for 22 years in two different institutions.

In answer to what, if anything, she found difficult about teaching first years she said she had no specific comment related to first year teaching. She felt teaching itself wasn't difficult and was an important part of her job as an academic. Rather, there was a challenge (rather than a difficulty) to make sure lectures were 'up to date, comprehensive, concentrated and informed'. Her comment therefore emphasised the practical aspects of teaching and not difficulties in explaining concepts.

In her answer about teaching subsequent years she mentioned poor behaviour in class, the use of mobile phones, and students leaving examinations before the allotted time. She went on express concerns that universities now provided too much support to students rendering them passive and not independent learners. She also remarked on the fact that students worried only about exams when she felt they ought to worry more about coursework. When asked to explain she said that coursework was a good test of critical thinking and thus quite a challenging assessment yet students claimed to find essays 'easier than exams'. Again her comments refer to operational aspects of delivery and not subject content, the 'how' and not the 'what'.

Interestingly she said she felt Psychology would be better taught if, as in the past, there was a final exam paper the answers for which required integration of the whole discipline rather than one single module. Thus her answer recognised the primacy of making connections, as mentioned above.

Finally she emphasised the importance of students appreciating graduate attributes and their future employability. One could argue that this answer captures the notion of transformation *of a person*. In an ideal world students are fundamentally changed in both mind and ability as a result of their university experience.

Psychology Students

Note that the psychology students were interviewed as a group owing to timetable constraints. This accounts for the more general and less detailed nature of their comments and the lack of direct quotes. Note that they did not refer to any examples remotely resembling a TC and that the obstacles they say they encountered are generic.

The psychologists mentioned that the structure of their degrees was such that in addition to their major of psychology they had to study sociology. They felt these two subjects were difficult to mesh together in terms of content and writing styles. This comment is interesting because it shows that students strove to make connections and were frustrated when they could not achieve this. It also illustrates that their concerns were about practical aspects of writing such as referencing since they are required to have expertise in both Harvard and American Psychological Association editorial styles.

They spent some time discussing their studies of research methods and statistics and said that these topics were particular stumbling blocks to progress. However they emphasised that since they were given good support and were taught in small classes they were able to overcome this obstacle.

Since the psychologists were interviewed so close to their exams understandably they were anxious. This meant that the majority of their responses were specific to the way the institution conducted the exam timetable and assessment calendar and the differing amounts of support available for different exams. A geography student also commented in this way, with both subject groups disappointed that the same amount of work can result in widely differing degree classes depending on the subject. There appears to be an assumption among many students that 'the grass is greener' in degree subjects other than their own.

General Discussion

TC's from the point of view of students versus lecturers

There was overwhelming consensus between students and lecturers within disciplines. For both groups the most crucial 'troublesome' aspects of the subjects were generic skills of learning. This is a comforting finding that shows 'shared cognitions' (Canon-Bowers & Salas, 2001) and that lecturers focus their efforts into developing learning skill within their disciplines and students do likewise. In addition both groups mentioned the challenges of learning academic writing skills and listed terminology and referencing to be particular obstacles in learning. However both groups also found the formulaic nature of writing styles rather inhibiting

Both groups of respondents agreed on factors that facilitated good performance. Lecturers said enthusiasm was vital and students confirmed this. Students commented that good staff-student relationships were crucial and lecturers commented similarly ('be human not an aloof person' - Geography Lecturer). There was also emphasis on mutual respect ('I know I can ask for advice from X and it will be good' - Geography student; 'I could interact with (the lecturers) at any time - in fact without them I couldn't have got through' - Geography student). Indeed the psychology students commented that their enjoyment of a module was largely down to how they connected to the teacher rather than the content of the module. Psychologists and Geographers who studied research methods and statistics agreed that they valued and benefitted from good teaching support.

Students remarked that an important step forward for them was when they realised that they could challenge lecturers. Moreover lecturers stated that when they taught they aimed for this response. Indeed, the lecturer in Medicine and the Geography lecturer used exactly the same statement - that you should ask students 'What do YOU think?'. Students for their part felt empowered by this approach (Don't

be afraid to challenge lecturers. It is more fun!'; 'You have a have feeling of growth and progress and understanding more when you put in your own opinions'- comments from two Geography students).

Both students and lecturers mentioned the primary importance of making links, and that it was at this point students felt they had command of their subject (cf. Carey and Spelke, 1998). This was shown by a geography student 'I found I had a change of thought between second and third year - we learnt how human geography linked into physical – you could explain how physical can explain human and vice versa'. Another geographer remarked 'I now realise everything is part of a system – but there are also things that don't fit'. An intercalating medical student remarked 'Clinical based blocks were much better and I understood the cellular level because of the clinical based information. The 'spiral learning' was great at allowing everything to fall into place.' Another student from the same course said 'I took a specialist course - pathology - I was very interested in the subject so it was easy to learn and I found that other areas overlap which helps to marry the course as a whole'. Conversely lecturers expressed the view that struggling students were those that 'ignore synergy, philosophy, pulling together, and critical appraisal' in their work (Lecturer in Medical Sciences).

A recurrent theme for all respondents was the *'how' not 'what'* of their studies. When asked what was difficult about third and fourth year a geographer said 'It was more skills than the actual ideas. I understand the concepts but it's how you put them into place'. The lecturer in Medical Sciences commented 'I am showing them the ropes of acquiring knowledge'.

Psychology students mentioned research methods and statistics as a particular difficulty of their subject. They also said that good support helped them to navigate this aspect of the course. One of the medical science students also identified statistics as troublesome. This theme was taken up by the Geography Lecturer, who said students sometimes had a 'mental block' about statistics and to overcome it 'You must teach (statistics) well - don't make it dull" he also mentioned that he was constantly striving to devise better ways of teaching the subject as he identified it as a difficult part of his discipline.

Many students and staff stressed the importance of the final dissertation and that even though it was the most challenging part of the degree they commented that it was also the most rewarding and was the point at which they felt a deep understanding of their discipline 'In a strange way it was difficult - but at the end it feels like your baby and you can't bear to let it go' (geography student). The psychology students commented that they felt that they had been preparing throughout their whole degrees for their project

Comment [S1]: Because this was not something mentioned by medical science students

and enjoyed being able to be independent and follow their own research interest. They saw the project as the pinnacle of their academic achievement.

Conclusions

Throughout our report we have revealed the remarkable consistency in the opinions of staff and students on the major obstacles to learning in their disciplines. With only a few exceptions TC's were not spontaneously identified and in contrast generic learning skills were brought to the fore.

The heart of the matter is that we should do everything in our power to enhance metalearning. In the most detailed empirical study to date Meyer, Ward & Latrielle (2009) examined the learning profiles generated by a 'Reflections on Learning Inventory.' (RoLI) for 354 Economics students. Completing the inventory acted as a metalearning experience. The authors compared the learning profiles before and after learning the threshold concept of 'elasticity'. Examination of the factorial structure of the RoLI responses and determined that there were marked positive changes in metalearning style after a period during which student reflected on their own learning patterns. Meyer et al make a strong case that relative short experiences of metalearning within the context of subject specific material can have a significant and measurable effect on student understanding of TC's.

Acknowledgements

We are grateful to the anonymous interviewees for contributing their time and opinions to the project and to Jennifer Herrick for conducting the interviews.

Comment [S2]: Give Jen a name check for conducting some of the interviews?

REFERENCES

Ashwin, A. (2008). Threshold concept acquisition in the 14-19 age group. In *Threshold Concepts within the Disciplines*. R. Land, J. H. F. Meyer, & J. Smith (Eds.), Rotterdam: Sense Publishers.

Baillie, C., & Johnson, A. (2008). A Threshold Model for Attitudes in First Year Engineering Students. In *Threshold Concepts within the Disciplines*. R. Land, J. H. F. Meyer, & J. Smith (Eds.), Rotterdam: Sense Publishers

Bloom B. S. (1956). *Taxonomy of Educational Objectives, Handbook I: The Cognitive Domain.* New York: David McKay Co Inc.

Bradbeer, J. (2005). Threshold concepts and troublesome knowledge in the GEES disciplines. *Planet*, 15, p. 3.

Bradbeer, J. (2006). Threshold concepts within the disciplines: a report on a symposium at the University of Strathclyde, Glasgow, 30 August to 1 September 2006. *Planet*, 17, 16-17.

Biggs, J. B. (1985). The role of meta-learning in study process. British Journal of Educational Psychology, 55, 185-212.

Cannon-Bowers, J. A., & Salas, E. (2001). Reflections on shared cognition. *Journal of Organizational Behavior*, Special Issue: Shared Cognition, *22, 195-202*.

Carstensen& Bernhard (2008)

Clifford, N. J., Holloway, S. L., Rice, S. P. and Valentine, G. (eds). 2009. *Key Concepts in Geography*, 2nd edition. London: Sage.

Clouder, L. (2005) Caring as a 'threshold concept': transforming students in higher education into health(care) professionals *Teaching in Higher Education*, 10, 505-517.

Cousin, G. (2006). Threshold concepts, troublesome knowledge and emotional capital: an exploration into learning about others. in J. H. F. Meyer & R. Land, (Eds). *Overcoming Barriers to Student Understanding: Threshold Concepts and Troublesome Knowledge*. Oxford: Routledge.

Cousin, G. (2006). An introduction to threshold concepts. *Planet*, 17, 4-5.

Cousin, G. (2007) Exploring threshold concepts for linking teaching and research. Paper presented to the International Colloquium: International Policies and Practices for Academic Enquiry, Winchester, April. Available from: http://portal-live.solent.ac.uk/university/rtconference/2007/resources/glynis_cousins.pdf

Cousin, G. (2008). Threshold concepts: old wine in new bottles or a New Form of Transactional Curriculum Enquiry?. In R. Land, J. H. F. Meyer, & Smith (Eds). *Threshold concepts within the disciplines*. Rotterdam: Sense Publishers.

Dearnley, C. and Matthew, B. (2007). Factors that contribute to undergraduate student success. *Teaching in Higher Education,* 12 (3), pp. 377_391.Fessey, C. (2002). The development of clinical nursing capability: an analysis of progression towards individual clinical and role skills in a surgical ward Learning in Health and Social Care 1, 202-217.

Flanagan, M., & Smith, J. (2008). From playing to understanding: The transformative Potential of Discourse versus Syntax in learning to Programme. In R. Land, J. H. F. Meyer, & Smith (Eds). *Threshold concepts within the disciplines*. Rotterdam: Sense Publishers.

GEES Subject Centre. (No date). *Geography, Earth and Environmental Sciences: Employability Profiles Resource Pack*. Available at: http://www.gees.ac.uk/projtheme/emp/geesempr.rtf [Accessed 28 July 2011]

Geographical Association. (2005). *The Power and Future of Geography in Schools.* Available at: http://www.geography.org.uk/download/NPOGfuture.doc [Accessed 28 July 2011]

Goswami, U. (2008). Cognitive development: The learning brain. New York: Psychology Press.

Hacker, D. J., Dunlosky, J., & Graesser, A. C. (2009). *Handbook of Metacognition in Education*. Oxford: Routledge.Isaacson, R. M., and Fujita, F. (2006). Metacognitive Knowledge Monitoring and Self-Regulated Learning: Academic Success and Reflections on Learning. *Journal of the Scholarship of Teaching and Learning*, 6, 39 - 55.

Hall, B. M. (2011). Threshold concepts and troublesome knowledge: towards a 'pedagogy of climate change'? In: Haslett, S. K., D. France and S. Gedye (eds), *Pedagogy of Climate Change*. Plymouth, UK: GEES HEA Subject Centre. Available at: http://gees.ac.uk/pubs/other/pocc/pocc.htm [Accessed 28 July 2011]

James, P. and Clark., I. (2006). Overcoming geological misconceptions. *Planet*, 17, 10-13.

Johnston, R. J. (1997). 'Graduateness' and a core curriculum for geography? *Journal of Geography in Higher Education*, 21, 2, 245-252.

Kastens, K., Manduca, C. A., Cervato, C., Frodeman, R., Goodwin, C., Liben, L. S., Mogk, D. W., Spangler, T. C., Stillings, N. A. and Titus, S. (2009). How geoscientists think and learn. *Eos Trans*actions, *American Geophysical Union*, 90, 31, 265-267 (4 August 2009).

King, H. (2006). Editorial: threshold concepts and troublesome knowledge. *Planet*, 17, 2-3.

King, H. (2008). Exploring practices, improving student learning: Threshold Concepts conference 2008. *Planet*, 22, 80-83.

Kneale, P. (2011). *Study Skills for Geography, Earth and Environmental Science* Students, 3rd edition. London: Hodder Education.

Kneebone, R. (2009) Simulation and Transformational Change: The Paradox of Expertise**.** *Academic Medicine,* 84 (7), 954-957.

LeBard, R., Thompson, R., Micolich, A. and Quinnell, R. (2009) *Indentifying common thresholds in learning for students working in the 'hard' discipline of science.* Conference Proceedings of Motiviating Science Undergraduates: Ideas and Interventions, Uniserve Science, The University of Sydney, pp.72-77. Available at: http://sydney.edu.au/science/uniserve_science/images/content/2009UniServeScience%20proceed.pdf [Accessed 27th August 2011]

Livingstone, D. N. (1992). *The Geographical Tradition: Episodes in the History of a Contested Enterprise*. Oxford: Blackwell.

Maudsley, D.B. (1979). *A Theory of Meta-Learning and Principles of Facilitation: An Organismic Perspective.* University of Toronto.

McCune, V., and Hounsell, D. (2005). *The development of students' ways of thinking and practising in three final-year biology courses.* Higher Education 49, 255–289.

Meyer, J.H.F. and Land, R. (2003).Threshold concepts and troublesome knowledge (1): linkages to ways of thinking and practising within the disciplines. In C. Rust, (Ed.), *Improving Student Learning – ten years on*. Oxford: OCSLD. Also available online, at http://www.etl.tla.ed.ac.uk/docs/ETLreport4.pdf [Accessed 27th August 2011]

Meyer, J.H.F and Land, R. (2005). Threshold concepts and troublesome knowledge (2): Epistemological considerations and a conceptual framework for teaching and learning. *Higher Education* 49, 373-388.

Meyer, J. H. F. and Ward, S. C. and Latreille, P. (2009) 'Threshold concepts and metalearning capacity.' *International review of economics education*, 8, 132-154.

Orsini-Jones, M. (2008). Troublesome Language Knowledge: Identifying Threshold Concepts in Grammar learning. In R. Land, J. H. F. Meyer, & Smith (Eds). *Threshold concepts within the disciplines*. Rotterdam: Sense Publishers.

Osmond, J., Turner, A., & Land, R. (2008). Threshold Concepts and Spatial Awareness in Transport and Product Design. In R. Land, J. H. F. Meyer, & Smith (Eds). *Threshold concepts within the disciplines*. Rotterdam: Sense Publishers.

Park, E. J. and Light, G. (2009). Identifying atomic structure as a threshold concept: student mental models and troublesomeness. *International Journal of Science Education*, 31, 2, 233-258.

QAA (2007). *Subject Benchmark Statement: Geography*. Gloucester: Quality Assurance Agency for Higher Education.

Riley, D. (2006). Modelling change with system dynamics and with threshold concepts. *Planet*, 17, 14-15.

MacDonald-Ross. G. (2007) *The HE Academy and subject-specificity*. HEA Subject Centre for Philosophical and Religious Studies. 6th June. Greenwich, UK.

Ross, P.M. and Tronson, D.A. (2007). Intervening to create conceptual change. Science Teaching and Learning Research including Threshold Concepts. 2007 National UniServe Conference Proceedings, University of Sydney . Available from: http://sydney.edu.au/science/uniserve_science/workshop/2007/index.html [Accessed 24th August 2011]

Shanahan, M., Foster, G., & Meyer, J. H. L. (2008). Associations among Prior Acquisition of Threshold Concepts, Learning Dimensions, and Examination Performance in First Year Economics. in R. Land, J. H. F. Meyer, & Smith (Eds). *Threshold concepts within the disciplines*. Rotterdam: Sense Publishers.

Shiners-Kennedy, D. (2008). The Everydayness of threshold Concepts: 'State' as an Example from Computer Science. In R. Land, J. H. F. Meyer, & Smith (Eds). *Threshold concepts within the disciplines*. Rotterdam: Sense Publishers.

Slinger, J. (2011). Threshold concepts in secondary geography education. Research report presented at the Geographical Association annual conference, University of Surrey, 16th April 2011. Available at: http://www.geography.org.uk/download/GA_Conf11Slinger.pdf [Accessed 28 July 2011]

Srivastava, S. K. (2010). Transformative and integrative dimensions of identified threshold concepts in geographical information systems. Paper presented at the 3rd Biennial Threshold Concepts Symposium, Sydney, July 2010. Abstract available at: http://www.thresholdconcepts2010.unsw.edu.au/Abstracts/SrivastavaS.pdf [Accessed 28 July 2011]

Sternberg, R. J. (1990). Metaphors of the mind: Conceptions of the nature of intelligence. Cambridge: Cambridge University Press.

Stokes, A., King, H. and Libarkin, J. C. (2007). Research in science education: threshold concepts. *Journal of Geoscience Education*, 55, 5, 434-438.

Taylor, C. (2008). Threshold concepts, troublesome knowledge and ways of thinking and practising - Can we tell the difference in biology? In Land, R. Meyer, J.H.F.& Smith J. (Eds). *Threshold concepts within the disciplines*, Rotterdam: Sense Publishers.

Taylor, C. (2006) *Threshold concepts in biology: Do they fit the definition?* In: Meyer, J.H,.F. and Land, R. (Eds.). Overcoming barriers to student understanding: Threshold concepts and troublesome knowledge, Ch. 6, pp.87- 99.London: Routledge.

Thrift, N. (2009). Space: the fundamental stuff of geography. In: Clifford, N. J., Holloway, S. L., Rice, S. P. and Valentine, G. (eds), *Key Concepts in Geography*, 2nd edition. London: Sage, 85-96.

Veenman, M., V. A., Van-Hout Walters, H. A., M. and Afflerbach, P. (2006). Metacognition and learning: conceptual and methodological considerations. Metacognition Learning, 1, 3–14.

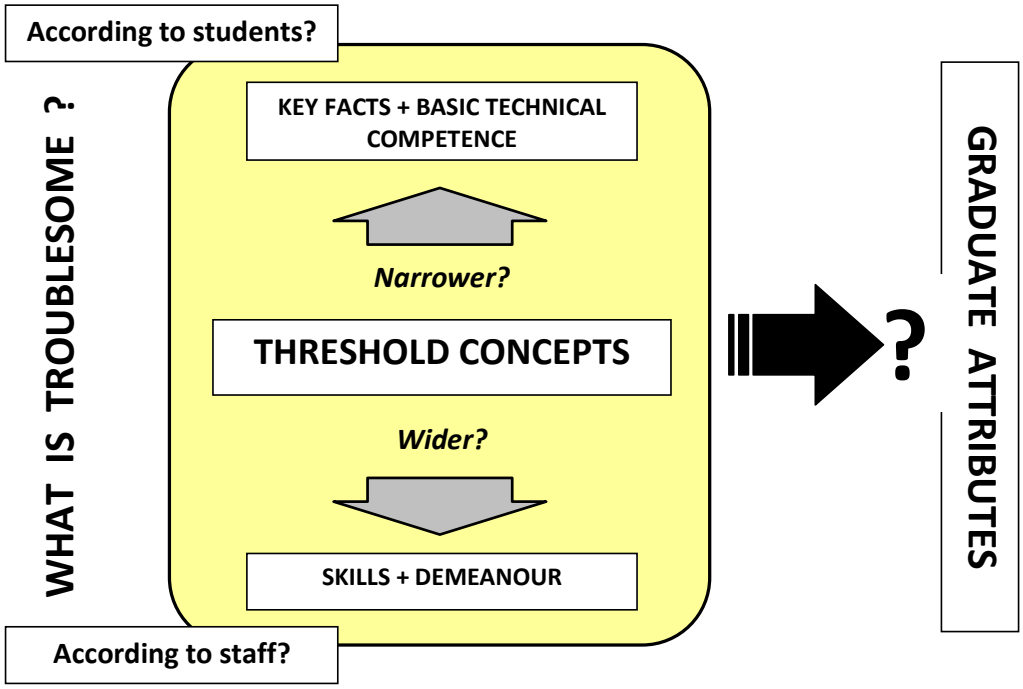
Ward, S.C. and Meyer, J.H.F. (2010). Metalearning capacity and threshold concept engagement. *Innovations in Education Teaching. International*, 47 (4), 369-378..Whalley, W. B., Saunders, Lewis, R. A., Buenemann, M. and P. C. Sutton. (2011). Curriculum development: producing geographers for the 21st century. *Journal of Geography in Higher Education*, 35, 3, 379-393.

Yip (1998) Identification of misconceptions in novice biology teachers and remedial strategies for improving biology learning. *International Journal of Science Education*, 20, 461-477.

Zander, C., Boustedt, J., Eckerdal, A., McCartney, R., Mostrom, J. E., Ratcliffe, M., & Sanders, K. (2008). Threshold Concepts in Computer Science: A Multi-National Empirical Investigation. in R. Land, J. H. F. Meyer, & Smith (Eds). *Threshold concepts within the disciplines*. Rotterdam: Sense Publishers.

Figure 1

Schematic comparing potential student and staff views on Threshold Concepts and Troublesome Knowledge



Appendix 1

Part 1

Basic discussion for students of all disciplines plus prompts for interviewer

An interview of this type does not attempt to achieve the rigour of experimental empirical research practice. Rathe,r it is a pilot under the rubric of 'action research'. However, to summarise our findings more easily and to increase the possibility of comparisons across disciplines the interviewer adopted the same basic framework for all disciplines.

What follows is not a script. The interviewer followed up students' comments and was able to depart from questions below if needed . Recording student opinions counted for more than tight design in the pilot study.

These discussions followed participants' written consent to join the study and to give permission for anonymous verbatim quotes. Full ethical approval for the project was granted by the University of Abertay, School of Social and Health Sciences, Research Ethics Committee.

Basic framework for discussions for students of all disciplines plus prompts for interviewer

The discussion followed written consent to join the study.

1. Introductions
2. Description of the project and explanation of their role in it

The following sentence was used to establish the scope and nature of the discussion.

'This project is part of a national enterprise in Scotland to develop optimum ways to teach (discipline) in universities. We are interested in your observations about studying (discipline)'

3. Setting ground rules (ethics, confidentiality, respect). Participants must avoid making personal comments about individuals. If this occurred the participant was reminded of the purpose of the data collection.

4. Discussion

Thinking about your studies in first year ...

What did you find easiest about your study of (discipline)?

(probe for specific discipline-related points but don't lead the interviewees)

Did you find any aspect of (discipline) particularly difficult?

(give some example if nothing forthcoming -

eg 'when I was a student, I found it hard to understand what an interaction in Anova meant' Would you say you have any examples of that sort of thing yourself?'

(if students do generate a specific aspect follow up with ...

Why was this?

As your studies progressed in subsequent years...

Did you find the same things difficult? if not, what new challenges did you discover in (discipline)?

(this question should be self-explanatory - but if they are not able to answer supply an example)

Was there a point when 'everything fell into place'?

Thinking about your final year studies only ...

What did you find easiest about your study of (discipline)?

(probe for specific discipline-related points don't lead the interviewees)

Did you find any aspect of (discipline) particularly difficult?

Why was this?

If you had to advise new students about the challenges of (discipline) what would you tell them? do you have any advice for them in tackling these issues?

5. Reflect back and thanks

Appendix 1

Part 2

Basic framework for discussions for lecturers of all disciplines plus prompts for interviewer

The discussion followed written consent to join the study.

1. Introductions

2. Description of the project and explanation of their role in it.

The following sentence was used to establish the scope and nature of the discussion.

'This project is part of a national enterprise in Scotland to develop optimum ways to teach (discipline) in universities. It is funded by HEA Academy Scotland as part of their Graduates for the 21stC initiative. The focus of this project is 'troublesome knowledge' or 'threshold concepts'. (explain here if participant not familiar with the concept. We are interested in your observations about teaching (discipline)'

3. Setting ground rules (ethics, confidentiality, respect). Participants asked avoid making personal comments about individuals. If this occurred the participant was reminded of the purpose of the data collection.

4. Discussion

Thinking about teaching students in first year ...

What did you find easiest about teaching first year (discipline)?

(probe for specific discipline-related points but don't lead the interviewees)

Did you find any aspect of teaching (discipline) particularly difficult?

(give some example if nothing forthcoming - eg 'when I started teaching, I found it hard to explain what an interaction in Anova meant' would you say you have any examples of that sort of thing yourself?'

(if they do generate a specific aspect follow up with ...

Why was this?

As you teach students in subsequent years ...

Did you find the same areas of teaching difficult? if not, what new challenges did you discover in teaching (discipline)?

Was there a point when 'everything fell into place'?

Thinking about your final year students only ...

What did you find easiest about teaching finalists/third year medics?

(probe for specific discipline-related points but don't lead the interviewees)

Did you find any aspect of teaching finalists in (discipline) particularly difficult?

Why was this?

If you had to advise new lecturers about the challenges of (discipline) what would you tell them? do you have any advice for them in tackling these issues?

5. Reflect back and thanks

Siobhan MacAndrew

November 2010

Appendix 2

Part 1

PARTICIPANT INFORMATION SHEET (LECTURERS)

PROJECT TITLE
How was it for you? A cross-disciplinary study of 'troublesome knowledge' as identified by undergraduate students and lecturers in Geography, Medical Science and Psychology

PROJECT TEAM
Siobhan MacAndrew (Psychology SC in Scotland)
with
Nicholas Spedding (GEES), University of Aberdeen
Susan Jamieson, MEDEV, University of Glasgow

PROJECT DESCRIPTION
This project is part of a national enterprise in Scotland to develop optimum ways to teach (discipline) in universities. We are interested in your observations about teaching (discipline)

Why have I been approached?
You have been approached because you are a lecturer in (discipline) and this project is concerned with the opinions of experienced lecturers in (discipline).

Must I participate?
No, participation is voluntary.

Will my students or employers be able to identify me?
No, your responses are anonymous and your students will not know whether or not you have volunteered. The discussion you have will be with a person unconnected with your work.

What will I have to do?
You will be asked to enter into a discussion about your experiences in lecturing (discipline).

Your participation is entirely voluntary. You can withdraw at any time for any reason without explanation. You may omit any of the questions should you wish to do so.

How long will it take?
You will be asked to attend a single individual discussion. You pace the discussion so the duration of the meeting is under your control. The session is estimated to take a maximum of 45 minutes.

Will my privacy be protected?
You will be anonymous in the report for this project and any subsequent publication based upon it. When you sign the consent form you will also be asked in a separate question whether you are happy for specific verbatim comments to be used anonymously. You may enter the study without agreeing to verbatim quotes.

What will you do with the data?
Your responses will be recorded during the discussion and transcribed later. The recordings will be destroyed within 4 weeks of the interview. You will be given a copy of the transcript so you can confirm it represents your opinions accurately. The notes from these discussions are anonymous with respect to respondent.

The project team are examining the opinions of students and lecturers in what they determine as particularly difficult aspects of studying (discipline). They will attempt to establish whether or not there is a match in these points of view. Finally the team will compare the responses of students and lecturers from Geography, Medicine, and Psychology in an attempt to determine whether there are commonalities in areas of learning across disciplines. The work will be written up as a report to Higher Education Academy Scotland and will form the basis of a presentation at a conference. It is possible that some aspects of the project may be used in later publications.

Appendix 2

Part 2

PARTICIPANT INFORMATION SHEET (STUDENTS)

PROJECT TITLE
How was it for you? A cross-disciplinary study of 'troublesome knowledge' as identified by undergraduate students and lecturers in Geography, Medical Sciences and Psychology

PROJECT TEAM
Siobhan MacAndrew (Psychology SC in Scotland)
with
Nicholas Spedding (GEES), University of Aberdeen
Susan Jamieson, MEDEV, University of Glasgow

PROJECT DESCRIPTION
This project is part of a national enterprise in Scotland to develop optimum ways to teach (discipline) in universities. We are interested in your observations about studying (discipline)'

Why have I been approached?
You have been approached because you are a final year student in (discipline) and this project is concerned with the opinions of experienced undergraduate students in (discipline).

Must I participate?
No, participation is voluntary.

Will my participation affect my mark or access to university facilities?
No

Will my lecturers be able to identify me?
No, your responses are anonymous and your lecturer will not know whether or not you have volunteered. The discussion you have will be with a person unconnected with your studies.

What will I have to do?
You will be asked to enter into an individual discussion about your experiences in studying (discipline).

Your participation is entirely voluntary. You can withdraw at any time for any reason without explanation. You may omit any of the questions should you wish to do so.

How long will it take?
You will be asked to attend a single discussion. The discussion will be paced by you so the duration of the meeting is under your control. The session is estimated to take a maximum of 45 minutes.

Will my privacy be protected?

You will be anonymous in the report for this project and any subsequent publication based upon it. When you sign the consent form you will also be asked in a separate question whether you are happy for specific verbatim comments to be used anonymously. You may enter the study without agreeing to verbatim quotes.

What will you do with the data?
Your responses will be recorded and transcribed and the recording will be destroyed within 4 weeks of the interview. You will be sent a copy of the transcript so you can check your opinions are captured accurately. The notes from these discussions are anonymous with respect to respondent.

The project team are examining the opinions of students and lecturers in what they determine as particularly difficult aspects of studying (discipline). They will attempt to establish whether there is a match in these points of view. Finally the team will compare the responses of students and lecturers from Geography, Medicine and Psychology in an attempt to determine whether there are commonalities in areas of learning across disciplines. The work will be written up as a report to Higher Education Academy Scotland and will form the basis of a presentation at a conference. It is possible that some aspects of the project may be used in later publications.

Appendix 2

Part 3

CONSENT FORM

PROJECT TITLE
How was it for you? A cross-disciplinary study of 'troublesome knowledge' as identified by undergraduate students and lecturers in Geography, Medical Science and Psychology

PROJECT TEAM
Siobhan MacAndrew (Psychology SC in Scotland)
with
Nicholas Spedding (GEES), University of Aberdeen
Susan Jamieson, MEDEV, University of Glasgow

PROJECT DESCRIPTION
This project is part of a national enterprise in Scotland to develop optimum ways to teach (discipline) in universities. We are interested in your observations about teaching(discipline)

I have read the Participant Information sheet associated with this project.

I have been given the opportunity to ask questions of the interviewer concerning my participation in this project.

I wish to participate in this project

signed:
date:

Furthemore **YES** I am happy for my comments to be quoted verbatim anonymously in the project report, conference presentation/s and any future publications

signed:
date: