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Publication Details

O'Donnell, R. M. (2009). Threshold concepts and their relevance to economics. *A TEC 2009: 14th Annual Australasian Teaching Economics Conference* (pp. 190-200). Brisbane, Queensland: School of Economics and Finance, Queensland University of Technology.

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Abstract

In exploring the learning experiences of tertiary students, some educationalists have advanced the 'threshold concept hypothesis' according to which certain concepts in various disciplines act as thresholds. Such concepts need to be mastered before further progress can be made in a discipline – they are thus like portals or entrances to be traversed before students can think like practitioners of that discipline. In economics, the concept of opportunity cost has been selected as a prime example of a threshold concept. This paper subjects the threshold concept hypothesis to critical scrutiny on logical and methodological grounds, and then investigates its applicability to the economic concept of opportunity cost. The main conclusions are that the hypothesis has serious definitional problems, construing opportunity cost as a threshold concept is difficult, and the hypothesis is enmeshed in problematic conceptual issues.

Keywords

Threshold, concepts, their, relevance, economics

Disciplines

Business | Social and Behavioral Sciences

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Threshold Concepts and their Relevance to Economics*

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ABSTRACT

In exploring the learning experiences of tertiary students, some educationalists have advanced the 'threshold concept hypothesis' according to which certain concepts in various disciplines act as thresholds. Such concepts need to be mastered before further progress can be made in a discipline – they are thus like portals or entrances to be traversed before students can think like practitioners of that discipline. In economics, the concept of opportunity cost has been selected as a prime example of a threshold concept. This paper subjects the threshold concept hypothesis to critical scrutiny on logical and methodological grounds, and then investigates its applicability to the economic concept of opportunity cost. The main conclusions are that the hypothesis has serious definitional problems, construing opportunity cost as a threshold concept is difficult, and the hypothesis is enmeshed in problematic conceptual issues.

Keywords: *Threshold concepts, opportunity cost, teaching economics.*

JEL Classification: A10, A20, D00

INTRODUCTION

Recently, some educationalists have advanced the proposition that there exists a class of concepts in certain disciplines, mastery of which is essential to further progress in that discipline. These concepts have been labelled 'threshold concepts', the metaphor being that of a doorway, portal or gateway through which one must pass to enter fully into the domain of the discipline. Some economists have taken up this hypothesis, selecting opportunity cost as a prime example of a threshold concept in economics. The practical import of the hypothesis lies in its implications for teaching, course design and learning evaluation, because such concepts are viewed as the *sine qua non* of further progress in understanding.¹

This paper subjects the threshold concept hypothesis to critical scrutiny, both in general terms and in the particular case of the concept of opportunity cost in economics. The opening sections outline the defining attributes of a threshold concept and investigate several problems with this definition. The extent to which the economic concept of opportunity cost satisfies the defining criteria is then explored, and the paper closes with some broader reflections. The conclusions drawn may be summarised as follows:

- (i) There are grave shortcomings in the definition of threshold concepts which prevent or problematise their identification in any discipline.
- (ii) In economics, it is difficult to accept that opportunity cost is a threshold concept because it does not appear to satisfy even a majority of the specified attributes.
- (iii) The threshold concept hypothesis generates methodological and conceptual questions which undermine its applicability and relevance.
- (iv) A good case for the superiority of the threshold concept approach over existing approaches is not apparent.

Before proceeding to detailed discussion, one general observation may be made. It is not always easy to be clear about the propositions and arguments advanced in the threshold concept literature for a variety of reasons – a large number of issues are raised, these are often discussed suggestively and all too briefly, the logic behind some discussion is not always transparent or coherent, inconsistencies emerge between various treatments of the hypothesis, and some examples used by educationalists drawn from disciplines outside their own are open to disputation. Distilling core elements of the hypothesis can thus be troublesome.

WHAT IS A THRESHOLD CONCEPT?

The notion originated with Jan Meyer in 2000 as a result of discussions with practitioners across a range of disciplines (Meyer and Land 2006a: *viii*). Apparently, economics played a significant role in its emergence through ‘research undertaken by the Economics team’ within a larger Economic and Social Research Council project (Meyer and Land 2003: 412).ⁱⁱ Since then, the concept has been embedded in a larger theoretical framework, the key papers here being Meyer and Land (2003) and Meyer and Land (2006a), the latter being a slightly updated but otherwise identical version of the former.

For a concept to qualify as a threshold concept, it needs to possess a number of specified characteristics. According to Meyer and Land (2006a: 7-8), a threshold concept ‘is likely to be’:

- (a) *Transformative*, because it causes a ‘significant shift’ in ways of understanding, interpreting, viewing or perceiving, ‘without which the learner cannot progress’. This property captures the gateway-like nature of threshold concepts as something through which the learner must pass in order to master the subject properly. As well as being intellectually transformative, it is also postulated that alterations of the learner’s identity and psychology may also occur.
- (b) ‘Probably *irreversible*’, because the transformation it engenders is ‘unlikely to be forgotten’ or will be ‘unlearned only by considerable effort’. Knowledge of the concept is so powerful that, once acquired, it produces virtually permanent changes in a person’s ways of interpreting the world and hence contributes to any transfiguration of that person’s identity.ⁱⁱⁱ
- (c) *Integrative*, because it exposes ‘previously hidden interconnections’ or an inter-relatedness between things that was previously obscured. Areas of a discipline that seemed isolated or separated from each other are, in the light of the threshold concept, revealed to have common themes, conceptual connections and greater coherence.
- (d) ‘Possibly often (though not necessarily always) *bounded*’, in that any conceptual space has ‘terminal frontiers’ bordering other conceptual spaces. Threshold concepts can thus be significant in demarcating the boundaries of disciplines or conceptual areas, and hence in defining communities of practice.
- (e) ‘Potentially (though not necessarily) *troublesome*’, in that learners find them difficult to understand and master for a variety of reasons, including ritual knowledge, inert knowledge, alien knowledge, tacit knowledge, and discipline language.^{iv}

As noted in the literature, the five properties are interdependent to a significant extent. For example, a concept that is either transformative in altering perspectives or integrative through bringing previously obscured things into view is likely to be troublesome; a concept that is transformative in the sense of being a precondition of further mastery is also likely to be boundary-defining in that discipline; and a concept that is irreversible is also likely to be transformative.

In coming to grips with threshold concepts, learners may move for some time in a ‘liminal’ or transitional zone stretching between poor comprehension and much fuller understanding. The time spent in the liminal zone may be short or long depending on the attributes of the concept, the learner and the teacher. But once thresholds have been crossed, learners enter the relevant community of

discipline practitioners.

DEFINITIONAL PROBLEMS

There are several serious problems with this definition.

1. How many characteristics are required?

Must all five attributes be present for a concept to qualify, or only a subset? If the latter, how many attributes are actually required, and should they constitute a majority? Such questions are critical for the identification of threshold concepts, but are not answered in the founding or subsequent literature. The section heading in the updated original paper, ‘Characteristics of a threshold concept’, suggests that all five are required, but this impression is undone by presence of words such as ‘likely’ and ‘probably’ in the definition (on which see below), and by the statement, in relation to one purported example of a threshold concept (opportunity cost), that ‘it may not be integrative’ (Meyer and Land 2006a: 7).^v The absence of guidance on these matters injects the first element of indeterminacy into the identification of threshold concepts – we are not told how many, or what combination, of the specified characteristics need to be present.

2. Can probable characteristics be defining characteristics?

Even if the above questions had clear answers, our problems are far from over. A new set of difficulties arise because of the incorporation of the words ‘likely to’ in the stem of the definition covering all attributes, and the words ‘probably’, ‘possibly’ and ‘potentially’ within the descriptions of three attributes. This creates something of a semantic jungle. What sense is to be made of something that is ‘likely to be probably *x*’, or ‘likely to be possibly *y*’? Is it meaningful to say that it is likely to be probably raining, or likely to be possibly sunny? More importantly, is it possible for a characteristic which is only *probably* characteristic of something to be a *defining* characteristic of that thing? It would seem not. The fact that most swans are white is not a defining attribute of a swan, for colour is irrelevant to being a swan. The purpose of a theoretical definition is to be definitive rather than conditional. If the attribute of a thing is merely likely, probably, possibly or potentially present, then it is automatically admitted that there may be instances of that thing without this attribute. How then are we to identify all instances of the thing? We cannot say it is this thing because it sometimes has the characteristic *z* and sometimes not, for that makes *z* irrelevant. Using conditional words to describe the attributes of a threshold concept destroys the definitional power of these attributes. Put another way, it is possible on the above definition for some threshold concepts to have all five characteristics, for some to have between one and four characteristics, *and for some to have none of the characteristics at all*. This renders the attributes impotent as definitional criteria. It means that the proffered definition provides no foundation for the identification of threshold concepts, and that whatever identification is occurring is using some other unspecified procedure.

3. How important is troublesomeness?

Taking the literature as a whole, it appears that troublesomeness is an extremely important attribute, but there are significant contrary statements that muddy the waters. On the one hand, Meyer and Land strongly associate threshold concepts with Perkins’s (1999) notion of troublesome knowledge – the discussion of troublesomeness in Meyer and Land (2006a: 4, 9-15) dominates that of all other attributes and takes up almost half the paper, while the main theme of Meyer and Land (2006b) is the link between troublesomeness and liminality, and how passages across thresholds can be beset by obstacles. Land *et al* (2006: 204-5) also claim that the significance of the threshold concepts framework lies partly its ‘potential to locate troublesome aspects of disciplinary knowledge’.^{vi} On the other hand, however, it is said more than once that threshold concepts ‘can’ or ‘may’ be troublesome, this theme being important enough to be incorporated into their definition by specifying that they are only potentially, but *not necessarily*, troublesome. This view has several implications, some of which are (intermittently) noted in the literature – that troublesomeness may be present in some cases but absent in others; that, when present, it might vary in degree; and that a threshold concept may be

troublesome for some learners and not others. Hence, despite its apparent importance, it is a less than vital attribute whose presence and significance varies with circumstances. Which of these contrasting views is 'right'? The absence of an answer allows further slipperiness and arbitrariness to enter the discussion.

4. Can threshold concepts ever have all five characteristics simultaneously?

One might expect threshold concepts to be troublesome in the early stages of learning, with troublesomeness receding as understanding improves. By the time the learner has grasped them properly and they have become transformative, irreversible, integrative and bounded, they ought to have lost their previous property of troublesomeness. In addition, it appears possible for different characteristics to be present at different stages in learning. A person's understanding could be transformative prior to its being integrative, for example. This implies that threshold concepts could possess subsets of characteristics that vary during the learning journey.^{vii} Davies (2006: 75-6), however, argues that at the end of learning all five properties are present simultaneously, his view being that the troublesomeness of threshold concepts follows from their integrativeness, an argument examined in a later section.

PROBLEMS WITH VIEWING OPPORTUNITY COST AS A THRESHOLD CONCEPT

Let us now turn to the discipline of economics, where opportunity cost has been singled out as a prime example of a threshold concept by several authors – Reimann and Jackson (2006: 116), Shanahan and Meyer (2006: 100), Davies and Mangan (2007: 722), and Meyer and Land (2003: 414-5, and 2006a: 5-6). It is not the only concept to have been selected (elasticity and general equilibrium being others), but it is the most prominent and common candidate. In examining whether opportunity cost qualifies as a threshold concept, I shall use a mix of logical, experiential and empirical argument, just as Meyer and Land have done, though our two mixes will be quite different.

Empirically, I shall rely on a recent revealing study by Ferraro and Taylor (2005) which reported on several surveys aimed at determining how well the concept of opportunity cost was understood by both graduates and undergraduates. Their primary survey was of 192 graduates, of whom 67% had a PhD and 33% were PhD students, about 61% had taught introductory university economics, and 45% were from 'top 30' economics departments in the US. This constituted a highly trained sample with considerable teaching experience. A single multiple choice question was used to assess understanding, this question being relatively straightforward within the standard (Neoclassical) framework. The results, however, were quite astonishing. The four alternatives attracted roughly equal percentages of respondents (25.1%, 21.6%, 25.6%, 27.6%) with the correct answer being chosen by the *least* number of respondents. The distribution of responses was virtually flat and hence no different from that expected from people untrained in economics or from a random selection process. Of those with experience in teaching economics principles courses, only 22.5% responded correctly. A second survey based on the same question was administered to 358 undergraduate students in the first week of introductory microeconomics before opportunity cost had been covered. Again the results were remarkable. Of the 24% of the class who had *not* taken economics before, 17.2% answered correctly, while of the 76% who had previously taken economics, only 7.4% were correct. No statistically significant difference was found, moreover, between the 21.6% of graduates who were correct in the first survey and the 17.2% of undergraduates who had not studied economics before and who were correct in this survey. This implies that 3 to 7 years of economics study has no overall impact on the ability to answer a relatively straightforward question on opportunity cost!

Let us now examine each of the five attributes of a threshold concept in relation to opportunity cost. Much could be said under each heading but discussion will be kept brief.

(a) Transformative

How do we know opportunity cost is transformative, either for students or for teachers (who once were students)? There is no reason to suppose that opportunity cost will have this attribute for all students (or lecturers), or even a majority of them. It may, or it may not. But if this attribute is absent, the learner does not have an intellectually transformative experience, cannot progress in understanding, and cannot attain mastery of the subject.

Consider a range of cases where ‘transformativeness’ is absent. Firstly, there will be students (possibly a majority) who only attain inadequate or mediocre understandings of opportunity cost but who nevertheless progress in the sense of graduating successfully at bachelor, masters or doctoral levels. Secondly, there will be students who develop good to excellent comprehension but who do *not* have transformative experiences because:

- (i) they are not majoring in economics (a large cohort in many introductory classes), so thinking or practising like an economist are largely irrelevant goals.
- (ii) they are majoring in economics because they want to understand how economists think and work without necessarily wanting to practise as professional economists outside academia; they could be pursuing careers in law, politics, philosophy, social policy, or even in economics (as academics), for example.
- (iii) they may be economics majors who react against the Neoclassical theory of cost, either because they are agnostic or because they find a non-Neoclassical theory of cost more plausible; these students could also become professional or academic economists.

The empirical evidence supports the above reasoning. The surveyed PhD holders and PhD students had achieved high levels of progress and had presumably gained significant mastery of the subject as a result of their training. Yet their understanding of opportunity cost was abysmal, from which it follows that it could not have been transformative for them. Since good knowledge of opportunity cost does not appear to be a requirement of graduation (even with distinction), perhaps such students should not have been allowed to progress. Why then was progress permitted? Was poor teaching accompanied by poor gate-keeping? One also observes that economics graduates do go on to pursue successful careers as economists in the private sector, public sector and academia. This implies that thinking and practising as an economist does not require a good understanding of opportunity cost and hence that this concept is not, on this criterion, defining the threshold that leads to the community of economists.

Of course, for some students opportunity cost may well be a transformative concept, but the above reasons suggest that such students and graduates will constitute a minority. If that is the case, the likelihood required by the definition is *reversed* – opportunity cost is actually *not* likely to be transformative, thus disqualifying it from possessing this characteristic.

(b) Irreversible

How do we know opportunity cost is irreversible for students? Irreversibility here means unlikely to be forgotten, or unlearned only by considerable effort. To the extent that irreversibility is associated with transformativeness, then the above arguments are also relevant here.

For knowledge to be irreversible, it needs to be (i) well understood during learning and (ii) subsequently embedded and retained in memory as a result of continued usage or application. Each of these conditions is far from guaranteed. Most undergraduate syllabi do not spend a great time on opportunity cost, partly because it is (incorrectly) introduced as a simple concept, and partly because it is explicitly discussed relatively infrequently in subsequent topics and courses. In graduate schools, particularly in the US, the emphasis is heavily on technical analysis rather than revisiting foundational

(and putatively simple) concepts such as opportunity cost. Nor do many practising economists necessarily have opportunity cost at the forefront of their minds in their daily work. In all these cases, knowledge of the concept can easily degrade over time, so producing unlearning. The empirical results also point to *reversibility* among the highly trained. Even faculty who taught opportunity cost in principles courses did very poorly in answering the question with only 22.5% responding correctly. In other words, there seems to be initial (and possibly partial) learning followed by much subsequent unlearning, which does not support the irreversibility postulate.

(c) Integrative

Is opportunity cost really a key integrative concept in economics? This cannot be true of the way opportunity cost is taught in standard lectures and textbooks where its integrative role is quite limited. After brief treatments early in introductory courses, it typically resurfaces in production possibility frontiers, introductory remarks on cost and in the discussion of comparative advantage. It may crop up again from time to time in second and third year courses, but its treatment is again typically cursory such that it plays a very small explicit role in conceptually integrating different parts of the curricula or uncovering obscured relationships between disparate economic phenomena. This may reflect poverty in the way the way it is taught, but most teachers these days model their teaching on leading textbooks, the authors of which are often world-renowned, and expert, economists.

(d) Bounded

The mainstream view is that opportunity cost is an essential concept in economics,^{viii} where what is actually meant by economics is Neoclassical economics (or possibly Austrian economics). Like all essential concepts in other theories or disciplines, opportunity cost then has the property of boundedness because it helps demarcate the framework in which it is deployed from other frameworks using different concepts to theorise the same phenomena. This makes it a bounded concept for Neoclassical economics (and other schools of economic thought of like mind), but not necessarily a bounded concept for economics as a whole. Hence for those schools in which opportunity cost is actually an essential concept, it will also have the property of boundedness.

(e) Troublesome

I also have no quarrel with the proposition that opportunity cost is a troublesome or difficult concept, both for students and for teachers. Here I am in complete agreement with the threshold concept literature,^{ix} although this view is contrary to the views of many mainstream economists who regard it as relatively simple and straightforward. The troublesomeness of opportunity cost can be argued on at least four grounds – when first encountered, the idea is an unusual one quite different from lay ideas of cost; it is not immediately intuitive and hence not easily retained in the mind; it introduces problematic conceptual issues in its application; and the empirical evidence indicates that both faculty and students find it troubling. In fact, for many graduates, the liminal state can apparently last longer than a lifetime without causing them much trouble working in the actual community of economists.

Is opportunity cost a threshold concept, then, on the basis of the above arguments? This returns us to the issue of indeterminacy in the number of criteria necessary for qualification. On my account, opportunity cost does not satisfy the first three criteria (transformative, irreversible, integrative); it satisfies the fourth (bounded) in a specific sense; and it strongly satisfies the last (troublesome). Assuming that two out of five is not a pass, I conclude that opportunity cost does not qualify as a threshold concept and, as such, doesn't function as a portal to becoming an economist, Neoclassical or otherwise. Curiously, this indeterminacy is implicitly admitted, but passed over in complete silence, in Shanahan and Meyer (2006: 102). After noting that 'threshold concepts possess a number of attributes' (only four are mentioned, with bounded being the unexplained absentee), they remark

without further elaboration that ‘opportunity cost would *appear* to possess *some* of these characteristics’ (emphases added). But we are not told which of the four are relevant, apart from troublesomeness.

VARIATIONS ON A THEME

Not everyone working within the new framework has followed the original path. At least two authors have, implicitly and explicitly, proposed variations on some of the ideas informing the hypothesis. In biology, Taylor (2006) asked whether putative threshold concepts satisfied the original definition. The difficulties encountered engendered dissatisfaction with the standard approach, which associates thresholds with specific concepts, and led to the suggestion that ‘threshold experiences’ might be a more fruitful way of thinking about the issue. This re-conceptualisation requires a more holistic approach which focuses on *a series of interconnected and progressively more abstract concepts*, through which improved understanding of the subject is developed over a period of time (possibly several years or more).

‘How can we recognise threshold concepts?’ is the highly pertinent question posed by Davies (2006), to which a rather complex answer is provided. He retains the five original characteristics (albeit without most of the probability-style qualifiers), but adds a sixth in saying that threshold concepts have a ‘taken-for-granted’ nature which leads to their omission from much teacher-learner dialogue and requires learners to develop understanding by reading between the lines. Davies’s general perspective, however, is that of *learners joining a community of practitioners* (74), this leading to a focus on the *processes* by which such concepts are identified and learned.^x At the end of a successful learning process, however, students will have crossed the threshold, mastered the ways of thinking and practising of the relevant community, see and interpret the world through the lens of that community, and take on changed identities.

This is an interesting variation but introduces some (unaddressed) difficulties of its own, chiefly because Davies emphasises the *integrative* attribute of threshold concepts and sees them emerging at, or near, the final stages of learning. One problem concerns his argument that threshold concepts should *not* be introduced early in a course but only at a time when students have ‘acquired sufficient subject knowledge...for them to attempt to develop and practise an integrated understanding’ (81). This would be a significant time later because, to be integrative, learners must already have acquired that which is to be integrated and because integration necessarily operates ‘at a high level of abstraction’ (80). At this later time, teachers have to ‘help students to re-interpret their current ideas in the light of the threshold concept’ (76). This is straightforward if the current ideas and the threshold concept are different, but how would it work in the case of opportunity cost? As a fundamental concept, it needs to be introduced early in the course, so how would a previously acquired idea (opportunity cost) be later re-interpreted *in light of itself*? Other questions also arise. When, exactly, is a concept a threshold concept – at the beginning when it is introduced, or only after a period of time when students can see and experience its integrative nature in relation to knowledge already acquired? Most writers select the first path, but Davies chose the second.

A second difficulty concerns his argument, noted previously, that threshold concepts possess all five characteristics simultaneously because ‘integrative’ implies ‘troublesome’. The argument supporting this proposition, however, subtly changes the original formulation by switching the locus of troublesomeness from learners to teachers. The concept is not troublesome to the learner as it was previously, but is now troublesome for the teacher, and in a different sense. Because the threshold concept is ‘inaccessible to the novice’ (75-6), novices may react badly to it – they may simply engage in rote-learning, or they may reject the entire subject as too abstract and meaningless. The teacher thus has the difficult task of juggling three things – retaining the interest of students, developing their necessary knowledge, and then, later on, re-interpreting their current ideas to reveal the integrative nature of the threshold concepts.^{xi} This radical redefinition of troublesomeness is contrary to the

original learner-centred formulation and its focus on the causes of troublesomeness. Thirdly, and less importantly, Davies notes that experts in the community identify the relevant threshold concepts, but also remarks that *learners* identify them as well. The inconsistency between these two statements is more apparent than real, however, because his following discussion implies that what is meant by the latter remark is not that learners identify them, but that learners need help in *recognising* the threshold concepts previously identified by the experts.

BROADER METHODOLOGICAL AND CONCEPTUAL ISSUES

1. What value is added by the threshold concept hypothesis?

Is the threshold concept hypothesis an advance on existing approaches or is it merely re-assembling existing ideas and presenting them in new garb? Existing approaches recognise certain concepts as ‘foundational’, ‘fundamental’ or ‘core’ in the sense that they underpin, and reappear in, later thinking, this giving them essential roles in understanding and interconnecting course material. Existing approaches also accept that conceptual frameworks have boundaries, and that certain key concepts can be ‘hard’ or ‘difficult’ for many students.

The new terminology could be seen as merely re-expressing previous ideas to a large extent, but advocates of the threshold concept hypothesis insist that the two approaches are different. Meyer and Land (2006a: 6) claim that a threshold concept is ‘something distinct’ within core concepts, the difference being that while core (or ‘building block’) concepts facilitate progress in understanding, they are not threshold concepts because they are not *transformative*.^{xii} Only one brief, inconclusive and context-dependent argument is provided in support – the concept of *gravity* is taken to be a threshold concept, but the concept of the *centre of gravity* is not, even though it is a core concept in applied science. The case is not well made, however, because we are not comparing like with like (the latter concept is a derivative of the former) and we are not remaining within the same discipline (in moving from pure to applied science). Further, why should the idea that complex body problems can be simplified by using centres of gravity not be transformative for some students in applied science? Davies (2006: 70) also distinguishes existing approaches from the threshold concept approach, largely on the grounds that existing approaches only address ‘ways of thinking’ whereas the threshold concept approach focuses on ‘ways of thinking and practising’. The difference does not seem to be large, however, because while ‘practising’ involves the *use* of conceptual knowledge in investigations, it is also stated that ways of thinking necessarily entail particular ways of practising.

In the absence of compelling argument, one is left wondering whether the claim is more asserted than supported, whether the threshold concept hypothesis is more akin to re-badging than innovation, and whether abandoning this approach to important issues would leave us poorer.

2. The unusual conceptual characteristics of threshold concepts

As concepts, threshold concepts are unusual in two ways. Existing approaches deploy fundamental, core, or building block concepts which are defined in terms of other concepts in the given framework. Such concepts are ‘objective’ in Popper’s ‘third world’ sense in that they exist in a conceptual realm independent of their psychological impact on humans.^{xiii} By contrast, threshold concepts are, to a significant degree, defined in terms of the effects the concepts have (or are supposed to have) on students, that is, in terms of the experiences of learners. Hence, since some of their characteristics are dependent on their psychological impacts on subjects, threshold concepts possess significant subjective dimensions as well as the objective dimensions noted above. This makes them quite unusual concepts.

This peculiarity is not harmless, however, for it creates ontological and epistemological difficulties. Firstly, in order to exist, threshold concepts must have the required impacts on the thoughts, perceptions and identities of subjects. An alleged threshold concept that is not transformative,

integrative and irreversible for the learner (or possibly some subset of these attributes) cannot presumably be a threshold concept. Secondly, in order to be identified as a threshold concept, the subjective impacts on learners need to be verifiable in convincing ways. To illustrate, suppose a situation in which a putative threshold concept is not producing the desired effects on learners. What happens next? The experts who put forward the concept could admit error but, more likely, they will criticise the teaching (hopefully constructively), to which criticism teachers could respond positively, indifferently or negatively.^{xiv} Both the existence and identification of threshold concepts then depends crucially on the approaches taken by, and the commitment of, teachers. Without ‘right’ teaching, the latent powers of the threshold concept will not be released. Existence and identification now depends on a circle of people – experts, teachers and learners. By contrast, fundamental concepts exist within a conceptual framework and are identified by their position in that framework; although identified by the experts in the given community (usually with reasonable consensus), their existence and identification are entirely independent of their impacts on learners and the methods used to teach them.

The second (related) difference between threshold concepts and fundamental concepts is that the former are defined in terms of a mixture of two heterogeneous attributes – desired attributes and actual attributes. An important implication of this difference is explored in the next section.

3. Is there a conflation of positive and normative concerns?

It seems the arguments for the threshold concept hypothesis either conflate, or come perilously close to conflating, positive and normative concerns. On the one hand, the hypothesis deals with claims about reality – the attributes that threshold concepts actually have, the community of practitioners in the real world (say economists), and what is required to enter into this community. On the other hand, the hypothesis also deals with claims about how things ought to be – threshold concepts are required to have certain attributes, learners should experience these attributes to deepen understanding, and learners should think and practise in these terms in order to be a proper practitioner and community member. These two sets of claims, one concerning reality and the latter an ideal state, are often merged in a subtle manner.

The problem stems from the fact that threshold concepts are defined in terms of a mixture of attributes – some are desired (transformative, irreversible, integrative), and some are actual (bounded and troublesome). It is the desired attributes that generate the problem, for these may be realised or unrealised. To simplify, let us say that a threshold concept should have at least one of the desired attributes.^{xv} Then for any given concept to be identified as a threshold concept, the desired attribute(s) must also be actual attribute(s). But what happens if they are not? The targeted concept cannot be a threshold concept. It could only be a threshold concept if we were in the ideal state and desired attribute(s) were also real attribute(s). For the concept to qualify as a threshold concept, the ideal state must thus already be present. Since advocates do say that some concepts are threshold concepts (such as opportunity cost), then the desired attributes must also be actual ones, that is, the normative has to coincide with the positive. The difficulties here are, firstly, that there is no guarantee of this and, secondly, that it is contrary to experience because we know that desired attributes are not always actually present in reality.

One might say that targeted concepts are *potential* threshold concepts, so we could then investigate to see if they actually were. But advocates do not take this approach because they need to identify threshold concepts in advance in order to induct learners into the community. How do they know that a given concept is a threshold concept? They accept the judgment of the discipline experts who have identified it as such. How do the discipline experts know? Because they believe that learners need to be taught to think and practise in this way in order to join their community. Membership is based on criteria that the experts value and think desirable. Thresholds are thus defined by the judgments and values of the experts, and if threshold concepts are not known in advance, the portals that novices must traverse to join communities are also unknown.

CONCLUSION

Meyer and Land (2005: 386) hope, reflexively, that the new notion of a threshold concept will itself be a threshold concept. By this they apparently mean that it could act as a new lens through which learning and teaching can be viewed, such that the new understanding is (likely to be?) transformative, irreversible, integrative, bounded and troublesome. However, given its lack of clarity and its logical and methodological problems, it might be more appropriate to view the threshold concept hypothesis as neither transformative, irreversible nor integrative, but as merely bounded and highly troublesome. While the hypothesis is grappling with the same important phenomena as existing approaches, its capacity to provide a coherent, fruitful way forward seems highly doubtful. To be convincing, a great deal more clear thinking on fundamental issues is required.

In economics, similar conclusions can be drawn in relation to the concept of opportunity cost, regardless of whether learners are majors or non-majors. While some students may see opportunity cost as bounded, and many experience it as troublesome, for most students it is neither transformative, irreversible nor integrative. It is thus difficult to see how it can qualify as a threshold concept.

Endnotes

ⁱ For threshold concepts in general, see Meyer and Land (2003; 2005; 2006a); for applications to economics, see Reimann and Jackson (2006), Shanahan and Meyer (2006) and Davies and Mangan (2007); and on the practical implications, see Land *et al* (2006) and Davies (2006).

ⁱⁱ Davies, another educationalist researcher in this area, has worked on a project to embed threshold concepts in undergraduate economics (Meyer and Land 2006c: *vii*).

ⁱⁱⁱ Davies (2006: 74) makes an even stronger claim here: 'The irreversibility of a threshold concept makes it *inconceivable* that they [the learners] would return to viewing not only the world around them, but also a subject community and themselves, in a way they did before' (emphasis added).

^{iv} For an extended discussion of these reasons, see Meyer and Land (2006a: 9-15) and Shanahan and Meyer (2006: 106-112).

^v No logical explanation of why opportunity cost may not be integrative is given. The paragraph intended to provide insight into the remark appears to be a non-sequitur – it deals with other matters, and actually implies that the concept is integrative.

^{vi} Many other authors in the Meyer and Land (2006c) volume are also closely preoccupied with troublesomeness. In some parts of these discussions, thresholds are simply interpreted as 'barriers' to understanding.

^{vii} This issue of time-varying combinations of characteristics is not discussed in the literature, but might provide a *partial* response to the above definitional question.

^{viii} See, for example Frank (2002: 460), Case and Fair (2002: 2), Hansen *et al* (2002) and Council for Economic Education (1997).

^{ix} See O'Donnell (2008).

^x All numbers in this paragraph refer to page numbers in Davies (2006).

^{xi} See also Davies's personal communication quoted in Meyer and Land (2006a:10).

^{xii} It may be noted that this argument introduces an inconsistency – it makes transformative a necessary attribute of a threshold concept whereas the definition merely requires likelihood. If transformativeness was not mandatory, some core concepts could be threshold concepts, thus contradicting the original claim.

^{xiii} See Popper (1972) chs 3 and 4.

^{xiv} Negative responses could include doubting the experts' abilities in this instance, rejecting the threshold concept hypothesis altogether or, in a case reported by Meyer and Land (2006a: 8), dropping the concept from the curriculum!

^{xv} By making the attribute necessary, the simplification removes the complications introduced by likelihood.

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