

# **Recognising Threshold Concepts: an exploration of different approaches**

**Peter Davies and Jean Mangan**

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Address for correspondence

Professor Peter Davies  
Institute for Education Policy Research  
Staffordshire University  
Leek Road  
Stoke-on-Trent  
ST4 2DF

Tel +44 (0)1782 294273

Fax +44 (0)1782 294070

e-mail [p.i.davies@staffs.ac.uk](mailto:p.i.davies@staffs.ac.uk)

## Introduction

Meyer and Land (2003) have proposed that in many disciplines there are *threshold concepts*, which can be ‘considered akin to passing through a portal, or conceptual gateway, thus opening up a new and previously inaccessible way of thinking about something.’ Such concepts lead to a transformed way of understanding, or viewing something that may represent how people ‘think’ in a particular discipline, or how they perceive, apprehend or experience particular phenomena within a discipline.

Threshold concepts offer potential help to lecturers in Higher Education who are grappling with two widely reported problems: students who acquire formal knowledge of a discipline but who seem unable to use this knowledge when making sense of everyday experience and students who struggle with underpinning theory and resort to verbatim learning of isolated aspects of the subject that they seem unable to use effectively in conjunction. However, to evaluate whether there is substance to this promise we need to be able to identify threshold concepts in a subject and this is not a straightforward matter (Davies, 2005a and b). Moreover, the process of trying to identify threshold concepts in practice should help to clarify how we should understand threshold concepts in the context of other contributions to the theory of learning.

Meyer and Land (2003) have defined threshold concepts as transformative, irreversible, integrative, bounded and potentially troublesome. A search for threshold concepts in a subject necessarily starts with an exploration of this definition. The last two of these characteristics derive from the first three: a threshold concept helps delimit the boundaries of a subject because it integrates a particular set of concepts, beliefs and theories. The stronger the integration, the sharper the boundaries of a subject will appear, as in the case of economics as currently taught in UK universities (Reimann, 2004). The looser the integration, the more the boundaries of a subject become open to debate. The more transformative a concept, the more likely it is to be troublesome because it requires reconfiguration of previously acquired understanding.

In fact, we might also see the first three characteristics as necessarily interwoven. A concept that integrates prior understanding is necessarily transformative because it changes a learner’s perception of their existing understanding. If a concept integrates a spectrum of prior understanding it is more likely to be irreversible because, once acquired, it holds together a learner’s thinking about many different phenomena. To abandon such a threshold concept would be massively disruptive to an individual’s whole way of thinking.

In this paper we first spend some time examining the relationship between threshold concepts, key concepts and conceptual change. In this section we aim to clarify the meaning of threshold concepts in relation to the literatures on conceptual change and phenomenography. We suggest three ways in which concepts may be understood and relate these to ‘threshold’ concepts. Each of these ways of understanding concepts carries a separate implication for the design of teaching and these are returned to in our conclusions. Having considered a framework for identifying threshold concepts we go on to review five sets of data that were gathered during the first year of the ‘embedding threshold concepts in first year undergraduate economics’ (ETC) project

based at Staffordshire University. We use this evidence to begin to appraise the framework developed in the first half of the paper. In summary, we find it helpful to think of threshold concepts as a web of subject knowledge, making the acquisition of a threshold concept a transformation of the learner's subject knowledge.

## **Threshold concepts and conceptual change**

The description of threshold concepts places it within the 'conceptual change' rather than the 'enrichment' tradition (Carey, 1991). In the case of enrichment, prior understanding eases the acquisition of a new concept (Pazzani, 1991). Practice in secondary and higher education often visualises new concepts as building blocks that can only be put in position once other necessary layers of understanding have been laid down. This perception leads to an emphasis on the role of foundation stones or key concepts in determining the overall shape and structure of understanding. By implication, one concept is more advanced than another because it requires more layers or prior understanding. This approach, often associated with Bruner's (1960) 'spiral curriculum', is evident in the account of different levels of achievement provided in the Framework for Higher Education Qualifications in England and Northern Ireland 2001 (QAA, 2001).

Carey (1991) suggests three categories of conceptual change in which a new concept emerges from a *reworking* of prior understanding. Each of these categories can be illustrated in relation to economic concepts. Firstly, a prior concept may be differentiated into two or more concepts. In the case of economics this can be observed when students differentiate for the first time between price and costs, wealth and income, real and nominal values or between savings and investment. There is a conceptual change here because, for instance, one conception of price is being replaced by another. Secondly, prior concepts may also be coalesced into a single concept. For example, the task of explaining a change in wages may come to be seen as identical to the task of explaining a change in prices since wage is the price of labour. Thirdly, a concept that is defined in terms of properties may be transformed into a concept defined in terms of relationships. A conception of price as a property of a product may be transformed into a conception of price as the outcome of relationships between demand, supply and quantity. Conceptual changes like these have been frequently observed in relation to price (Dahlgren, 1984; Thomas, 1985; Pong, 1997).

These changes have usually been presented in terms of a naïve or 'common-sense' understanding being supplanted by a more powerful discipline based mode of thinking and we will refer to this as a 'basic' conceptual change. The notion of 'troublesomeness' comes into play here insofar as ideas from disciplines run counter to the 'common-sense' notions that have been developed as individuals make sense of their experience. In the case of economics it seems likely that narrowness of experience is one cause of this problem. Learners have one-sided experiences on which to draw. In making sense of prices they have much greater experience as consumers than as producers. They have much greater experience of saving than investment. Yet, evidence that the economic misconceptions of adults are broadly similar to those of adolescents (Furnham and Lewis, 1986; Walstad and Larsen, 1992) suggests that the accumulation of experience of the economy does little to reduce this

problem. Another source of difficulty in economics arises from the subject's treatment of decision-making. One 'rule-of-thumb' that can be culturally transmitted is that decisions should take into account effort or resources that have already been committed ('sunk costs'). 'Opportunity cost', which is central to mainstream economic analysis, suggests that these costs should be ignored in decision-making. The acquisition of a concept such as opportunity cost ought to be transformative insofar as it has been integrated into the way an individual views their everyday experience.

However, acquiring the 'way of thinking and practice' in a subject (ETL Project, 2005) requires more than understanding these ideas. Academic ideas which are retained as isolated objects remain inert in the learner's thinking: the expected outcomes of 'surface' approaches to learning (Entwistle & McCune, 2001). In the words of Perkins this might be called 'ritual knowledge'. A 'deep approach' to learning helps the learner to employ newly acquired discipline concepts in making sense of each new set of phenomena they encounter. If we might ask a learner to distinguish between correct and incorrect uses of the concept in given statements of principle or examples we only discover if they have acquired an isolated object of knowledge: a typical product of surface learning. If we might pose a simple decision-making problem rooted in experience relevant to the student and framed in a way that might be answered either by referring to sunk costs or opportunity cost we may hope to discover whether the learner is using the concept to make sense of novel situations: a typical outcome of deep learning. It is only when the concept is used in this way that we may talk of it being transformative. The extent of the transformation might be gauged by the range of situations in which the learner considers deploying the concept.

However, conceptual change may also operate at a more profound level through the acquisition or organising schemas of thought that may be associated with the development of disciplinary thought. Carey (1991) compares conceptual change with the development of scientific thought from phlogiston to oxygen theories of burning. Phenomenographic studies have associated more advanced conceptions of force with Newtonian physics and more advanced conceptions of price with Marshallian supply and demand analysis. These developments in academic thought have not occurred simply through supplanting naïve, common-sense, notions by more powerful explanatory frameworks. New developments within subjects change the way that members of academic communities think about other ideas that have been developed within the discipline. In the case of the replacement of the Phlogiston theory, component ideas may fall away into disuse. However, in other cases old ideas are re-worked and subsumed within new theories. In these cases the acquisition of a new concept is transformative insofar as it integrates and reworks other disciplinary ideas that the learner has previously acquired and we will refer to this as a 'discipline' conceptual change.

In Table 1 we refer to this scale of conceptual change as 'discipline thresholds' which are associated ways of practising the subject: the discipline specific procedures that are used in the construction of narratives and arguments. In Table 1 these 'ways of practising' are referred to as modelling. For example, economists make considerable use of the notion of 'ceteris paribus' (all other things being equal) in their reasoning. Economists use this idea in lieu of being able to conduct closed experiments so it is

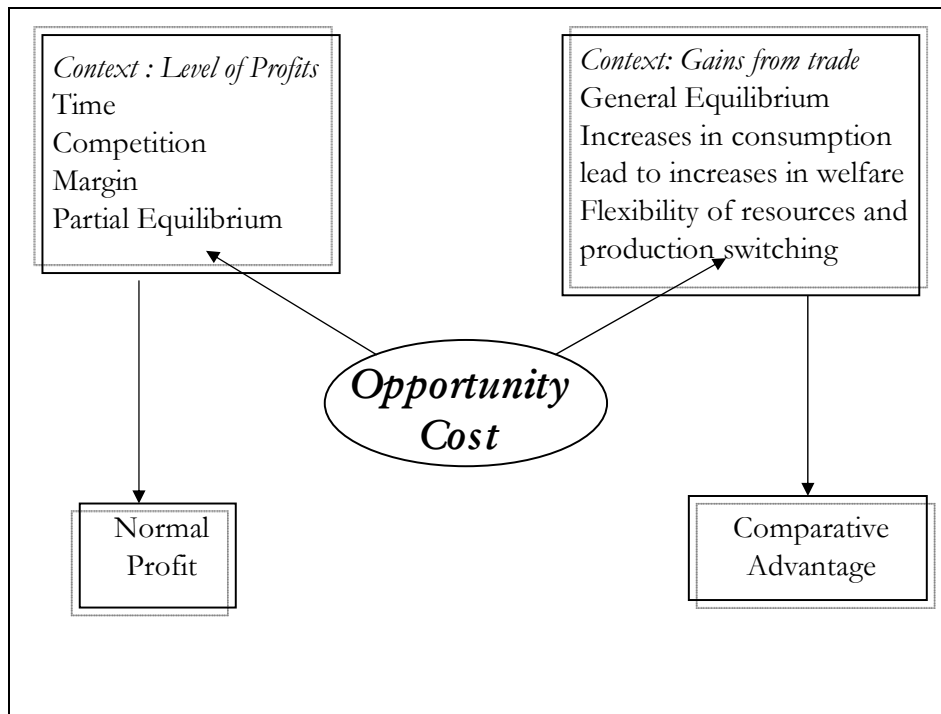
employed as a ‘what if’ assumption in deductive reasoning. A student who has not learned how to use this device appropriately will have great difficulty in constructing narratives that appear appropriate to an economist. Learning how to select, amend and test economic models is a central part of undergraduate education in economics and we will refer to this as a ‘modelling’ conceptual change.

**Table 1 Definition and exemplification of three types of conceptual change**

<i>Type of conceptual change</i>	<i>Type of transformation and integration</i>	<i>Example in economics</i>
Basic	Understanding of everyday experience transformed through integration of personal experience with ideas from discipline.	Distinctions between price/cost; income/wealth (stocks/flows); nominal/real values; investment/saving. Opportunity cost. Elasticity
Discipline	Understanding of other subject discipline ideas transformed through acquisition of theoretical perspective	Partial equilibrium. Interactions between markets. Comparative advantage.
Modelling	Ability to construct discipline specific narratives and arguments transformed through acquisition of organising idea	Ceteris paribus, time (short-term, long-term, expectations)

We can illustrate the distinctions between the rows in Table 1 by looking again at the acquisition of the concept of ‘opportunity cost’. The analytical power of this concept is only realised when it is used in conjunction with other economic ideas. For example an economist’s explanation of the level of profits in a competitive industry and an economist’s argument about the desirability of free trade would necessarily involve opportunity cost. However, opportunity cost is not sufficient for an economist’s perspective on either of these issues (Figure 1). The explanation of profits in a competitive industry requires the notions of partial equilibrium and the margin as developed in the ‘the years of high theory’ (Shackle, 1967). The argument about the desirability of free trade requires assumptions about flexibility of resources for production switching and the effect of increases in production on welfare which were brought together by Ricardo (1821) in the theory of comparative advantage. Acquiring an understanding of the theory of comparative advantage does not precipitate an understanding of partial equilibrium theory of profits. However, acquiring either one of these theories transforms the use to which a learner may put their understanding of opportunity cost and may also transform their perception of the relationship between opportunity cost and other economic ideas that they have acquired.

**Figure 1 Opportunity Cost in the context of broader understanding**



These examples of economic theorising have been notoriously troublesome for students and this may result from the embodiment of modelling thresholds in the theorising used to develop ‘comparative advantage’ and ‘partial competitive equilibrium’. For example, both theories are concerned with equilibrium positions and accept that it is reasonable to simplify to ‘typical organisations’ and that what will be true for particular cases will be true in general. In other words, the examples of discipline conceptual change in the second row of Table 1 require the modelling conceptual changes in the third row. Additionally the modelling conceptual changes act simply as enabling devices that make it reasonable to think in the terms suggested by the discipline conceptual changes in row 2. Thus we are not looking for a set of isolated ‘magic concepts’ but for a web of concepts that stand in a particular relationship to each other, arising partly from the historical development of thinking in a subject. Where successive developments in a subject incorporate previous thinking, a tightly structured set of discipline understanding develops. When successive developments in a subject stand largely in opposition to each other the relationships between ways of thinking in the subject becomes looser. However, in both cases a learner who grasps the significance of a theoretical development in the subject attains a new perspective on other aspects of the discipline.

We would see discipline and modelling conceptual change as ‘thresholds’. Discipline conceptual changes are transformative in that they give a unified view that integrates concepts, for example individualism, marginality, opportunity cost in partial equilibrium, where the whole is more than simply recognition of these parts. These concepts are over-arching, acquiring the concept may transform the use to which a learner may put their understanding of for instance, marginality, and may also transform their perception of the relationship between marginality and other economic ideas that they have acquired. The modelling concepts are ‘enablers’ without which a student cannot achieve a deep level understanding of the discipline concepts and so again are integrative and transformative and may be considered as threshold concepts.

With basic conception change the situation is less clear. It may be that these concepts, although seen as 'key' concepts within the discipline are not threshold concepts. They do not have the integrating nature of discipline concepts. However, some of these concepts are distinctly 'troublesome' for students and some are very much part of the 'web' of concepts, are used in many areas of economic analysis as part of the economist's 'toolbox' and related to 'thinking like an economist'. For example, elasticity is a concept that is used in conjunction with other economic ideas in a wide range of theoretical and empirical topics, for instance, in profit maximisation by the firm and in determining the effect of monetary policy. It is integrative in that a student who fully understands this concept will recognise and use this same tool in different areas of the discipline and it may be transformative in that understanding gained from use in a particular discipline area may lead to deeper understanding of a topic in a very different area. On that basis it is possible to argue that this is a 'threshold concept'.

In the next section of the paper we consider the views of economics lecturers and then in the next four sections we summarise other evidence from the types of data that have been gathered through the work of a project 'Embedding Threshold Concepts in First Year Undergraduate Economics' (ETC project). A brief rationale for the form of the data collection is given at the start of each section. The data was collected from four universities (denoted A to D) and the students included both specialist economists and non-specialists taking level one economics modules. Since economic modules are studied widely by non-specialists at university, an important part of our project is to consider this group.

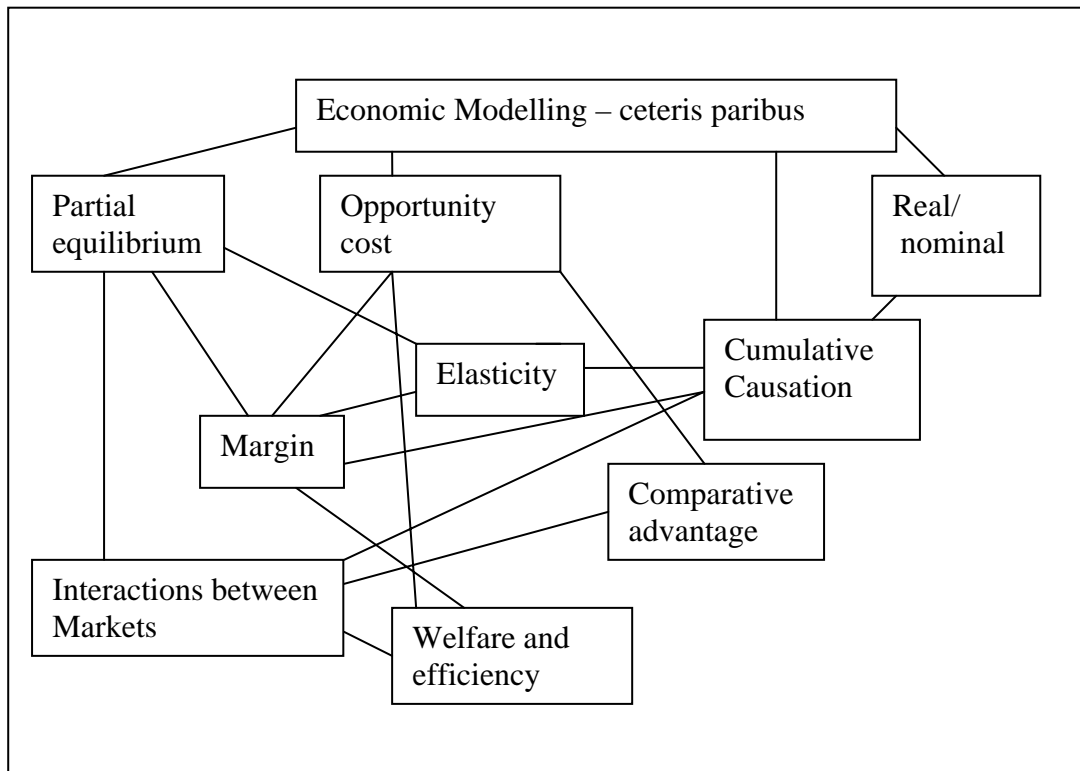
### **The views of economics lecturers**

The idea of 'threshold concepts' was developed by the team of researchers in the 'Enhancing Teaching and Learning Environments' project (<http://www.ed.ac.uk/etl/>) As part of this project, lecturers in a small number of disciplines, including economics, were asked if they could identify threshold concepts in their subject. We replicated this approach with 29 colleagues in three universities. Between them these colleagues nominated 42 concepts (some closely related), although only eight were nominated by five people or more (with opportunity cost and the margin being the most popular). As argued by Davies (2005b) there are reasons for expecting lecturers to interpret this request according to their prior understanding of the nature of concepts, and in particular key concepts, in their subject. Given the attested homogeneity in teaching of mainstream economics in English universities (Reimann, 2004) this diversity might seem surprising: unless it reflects variation in the way that individuals are interpreting the idea of a 'threshold concept'. Some of the diversity reflected some lecturers list more over-arching concepts, such as welfare economics, while others listed concepts that were parts of these, for instance, externalities, which relates to our 'basic' and 'discipline' concepts in table 1. Modelling concepts were mentioned by some but not by others, but this may again be simply a reflection of the interpretation of what was wanted.

The group of six economics lecturers in the FDTL5 project team spent considerable time wrestling with how to identify threshold concepts, reflecting on the evidence assembled in this paper and debating their interpretations of evidence with Meyer and Land and other colleagues participating in the project. Although some disagreement remained about the inclusion of different ideas as ‘threshold concepts’ there was increasing agreement about how threshold concepts should be understood and which economic ideas should be considered as threshold concepts. In particular, it was agreed threshold concepts should be regarded as concepts which reshape learners’ conception of economic analysis and equip them to use a range of economic ideas and problems more constructively. In terms of Meyer and Land’s criteria, it was the ‘integrative’ and ‘transformative’ that was felt to be the key attributes. We also felt that in most cases these would be ‘troublesome’. Some members of the group wished to include a longer list of threshold concepts, whilst others preferred to restrict the use of the term threshold concept to the ideas identified in Table 1 as ‘discipline thresholds’.

Importantly, the group stressed that it was more helpful to think of a web of threshold concepts, in economics at least, given the integrated nature of mainstream analysis in the subject. It is when students learn to use more than one threshold concept in analysing a problem that their full power is realised. In Figure 2 some links between threshold concepts are indicated by the lines. These do not indicated direction because this may not be unidirectional and indeed are not meant to be complete. With some threshold concepts there may be an order in which they need to be acquired. For instance, acquiring an understanding of opportunity cost is necessary to understand comparative advantage and welfare and allocative efficiency may need an understanding of interactions between markets. With other concepts there is not necessarily an order and may depend on the actual problem we are analysing.

**Figure 2 A summary of the view of threshold concepts in economics developed by the ETC Project up to July 2005**



### Short problems given to students and staff

We devised brief descriptions of problems that an economist might analyse. Each description aimed to avoid cueing appropriate concepts to be used in responding to the problem. Our intention was to discover what differences there might be between staff and student responses we posed the problems to about a dozen lecturers from two universities and just over twenty students in each case. Our assumption was that lecturers in economics would have acquired each of the dimensions of concepts identified in Table 1 and these would be highlighted through comparison with the responses of first year undergraduate students. The students had studied only part of an introductory economics module and were on a range of awards including economics, accounting and technology. Two of the problems are shown in Table 2.

**Table 2 Examples of problems posed to first-year economics students and staff**

	Problem
1	You receive a briefing about a financial services company that has recently set up a call centre in India. The wages paid in the call centre are a small fraction of the wages previously paid by the company to workers in the UK. The briefing asks for your support on a campaign to boycott the company's products on the grounds that it is exploiting workers in India and damages employment in the UK. How would you work out whether this campaign merits your support?
2	A large foreign owned car manufacturer is considering closing down its UK factories and moving its production to South East Asia. The company approaches the UK government and asks for a subsidy that would make it financially attractive for the company to keep its production in the UK. How should the government work out what its response to this offer should be?

Two examples of staff responses to problem 1 were:

*'The question is concerned with costs and benefits. There are benefits for workers, the community and the Indian nation. With further spillovers in the form of increased imports (maybe from Britain). Conversely the losses for the UK economy are the converse of the above thought in the medium term such resources could be more efficiently used'*

Lecturer, University C.

*'Applying concept of 'comparative advantage' and opportunity costs' one would argue that there are gains from trade to both Indian and UK workers. One would investigate the implicit notions behind this view that there is equilibrium in labour markets and the transition to the new equilibrium occurs quickly/costlessly'*

Lecturer, University A

These examples are typical of the kind of response provided by staff. There is explicit reference to economic concepts (e.g. comparative advantage, opportunity cost, equilibrium) and these are linked together in a fairly terse way. Both responses treat economies as dynamic systems in which outcomes result from the speed with which the economy moves to a new equilibrium and the cumulative causation or spillover effects that occur along the way. In addition, both these responses are sceptical of the campaign suggested in the problem.

In contrast, many of the students took it as self-evident that the campaign would be justifiable and that the only issue was the extent to which they should support it.

*'Write to the newspapers, show everyone how the company is exploiting workers in India and damages employment in UK'*

Business Studies Student 1, University C

*'With the information that I have got, I think it is unethical for this company to exploit the workers in India, by giving them low wages.'*

Business Studies Student 2, University C

Some students were beginning to think in terms of the opportunity cost faced by workers in India.

*'I would first consider whether moving the call centre abroad significantly damages the UK economy. If there are no detrimental effects, I would not support such campaign as it surely is providing jobs to unemployed people in India who I'm sure would not feel they were being exploited as they now have a secure salary and can provide for their families'*

Student 3, University C

The phrase in this response 'if there are no detrimental effects' suggests that the student does not feel equipped to identify what kind of detrimental (or positive effects) there might be. This contrasts sharply with closely integrated responses from members of staff.

Similar differences emerged from a comparison of staff and student responses to the second problem in Table 2.

*'Assuming there is long long-term rationale for relatively labour-intensive manufacturing in the UK – needs to assess the medium term benefit of a managed decline in employment in this sector against the opportunity costs of the subsidy and the delayed reallocation of labour and other resources for employment in other sectors which are currently sustainable in the global economy'*

Lecturer, University C

This lecturer begins by setting a provisional boundary on the nature of the problem in the manner of *ceteris paribus*. She goes on to use opportunity cost in relation to the speed of transition: weighing lost opportunities against potential costs from rapid transition.

Students concentrated on the effect of immediate job losses in the UK

*'They should work out what the company offers the UK economy for example, how many jobs would be lost. Whether the company uses UK suppliers or not. How popular the company is i.e. sales figures. How much more/less money people will have to pay for the cars if they have to be shipped over.'*

Student 4, University C

The better answers recognised some wider issues, but as with student responses to problem 1, there was little evidence that students had developed a way of predicting possible costs and benefits. Only one student answer considered the opportunity cost of the subsidy.

These findings are consistent with the different types of conceptual change suggested in Table 1. Opportunity cost is an idea explained in the early stages of introductory economics modules, but for many students it does not become integrated into their thinking and so when they are not prompted to use the idea it remains inert and redundant in their thinking. Other students have begun to integrate it into their

thinking but they lack the additional discipline thresholds to make the kind of use of the idea that is typical in the thinking of experts in the subject. The most striking contrast between the responses of staff and students to these problems was the degree to which lecturers' answers were tightly structured through the interplay of discipline ideas.

### **Open ended written questions on economic analysis**

In order to explore the degree of integration in first year students' thinking by asking three questions about their understanding of economic analysis:

- Could you please describe how you think an economist goes about analysing the economy? Try to include a description of what economists might actually do and in what sequence.
- Can you explain what factors or experiences have influenced your conception of what 'economic analysis' is?
- Do you think that you have, and make use of, a 'mental model' of economic analysis? Can you please explain it in terms that someone else would understand?

The responses analysed here are from 120 students from universities C and D and was again these students were part way through an introductory module. These were analysed independently by two researchers who then met to compare the way they were categorising students' answers to the first two questions. The agreed categories are used in the rows of Table 3. The degree of agreement in using the categories was high and is shown in the second column. The most disagreement occurred in the judgement of whether students were referring to the evaluation of economic outcomes. Students who have a 'mental model' may be starting to appreciate the importance of using economic concepts in combination to approach problems. The marking of both researchers suggested that there is a difference between the answers of students who believe they have some kind of mental model of economic analysis and those who believe they have not.

**Table 3 Comparison of Responses of students indicating they had some kind of mental model of economics and those who said they did not**

	Percentage of students with emerging mental models n= 34	Percentage of students with no mental models n=86	Percentage of students with emerging mental models n= 34	Percentage of students with no mental models n=86	Between marker reliability %
	Researcher 1		Researcher 2		
<i>Understanding of Economic Analysis</i>	%	%	%	%	
Gathering and analysing data on the economy	50	56	47	55	89
Attempting to look at the big picture	41	7	41	10	95
Identifying Flows of money	29	14	26	12	95
Evaluating economic outcomes	35	34	50	45	83
Listing topics for study	3	23	6	21	90
Economic Theorising	12	9	18	13	93
<i>Source of understanding cited</i>	%	%	%	%	
Current Study	53	57	53	53	91
Previous Study	21	8	21	12	92
TV and News	24	28	24	26	95
Personal Experience	18	1	18	3	96

Students who believe they have a mental model of economics were more likely to suggest that economic analysis involves ‘looking for the big picture’, less likely to suggest that economic analysis is the sum of a list of topics (such as ‘inflation’, ‘balance of payments’ etc.) and more likely to claim that their view of economic analysis has been influenced by their personal experience and in previous study. In each case this involves less than half of the students who reported that they had their own mental model of economics, so at most this is a tendency. However, there is a consistency in the pattern linking a holistic view of the subject to the integration of personal and academic experience even at this early stage of student’s study of the subject.

## End of module questionnaire: students' reporting of what was difficult and what helped their learning

Since threshold concepts might be troublesome for students we supposed that if they were asked to identify difficulties they had experienced in their learning then they might refer to threshold concepts. We collected evidence from first-year economics students at universities A and C by asking them to complete an open ended questionnaire at the end of their study of an introductory module. Two questions were posed: 'What did you find the most difficult and why?' and 'Which material in this module has most helped improve your understanding of economics?' The sample (n = 289) included students on economics degrees and students enrolled on other degrees which included introductory economics in the first year.

As might be expected, the responses to the question 'What did you find the most difficult?' provided plenty of evidence of students facing difficulty because they were trying to memorise isolated chunks of the subject with this approach focused on trying to learn diagrams:

*'The most difficult aspect in the module ...is trying to remember a lot of diagrams that are use in economic theory'' Student 5*

*'The most difficult sections of this model were: (i) the Keynesian model of income determination. (ii) IS-LM analysis, (iii) AD/AS analysis. The reason for this is that there quite a lot of diagrams and associated algebra that needs to be thoroughly revised in order to memorise them for future modules.'*  
*Student 6*

However, other students tried to identify what had made these graphs so difficult to learn and how they had managed to develop their understanding of the graphs:

*'The graphs pertaining to supply and demand curves. I could grasp the concepts easily, I didn't know how the movements of the demand and supply curves worked, as a result I spent more time mastering the graphs' Student 7*

*'I found marginal cost curves the most difficult to begin with, but once I studied them properly I came fully to understand them. I expect this was because it was the first time I had seen a graph with so many curves on at once.'* Student 8

*'Elasticity of demand diagrams, it was difficult to grasp the concepts, also when one variable changes how it affects others.'* Student 9

Whilst we might interpret these difficulties in terms of the use of mathematics in the subject, it might be more appropriate to view the difficulties as focused on the problems students experienced in acquiring an economics way of thinking. For instance Student 7 may be grappling with the ceteris paribus whilst Student 8 may be trying to come to terms with the way in which the graph was being used to

illustrate the notion of equilibrium and differences between the marginal and average.

This interpretation is made more probable by a comparison of the most frequently cited source of difficulty and the most frequently cited ‘most helpful’: demand and supply in both cases. A large number of the students who cited supply and demand as ‘most helpful’ justified their assertion by explaining that understanding supply and demand had helped their understanding of other parts of the course.

*‘Supply and demand – key concept and helped me understand other areas’*  
Student 10

*‘I found as I understand the supply/demand curves it greatly helped me to learn other module topics’*  
Student 11

Although the evidence here is not strong in itself, these statements are consistent with the description of ‘discipline threshold’ in Table 1. Understanding supply and demand was problematic for students, but once they had grasped its significance it unlocked their understanding of other parts of the course. Moreover, some grasp of economic modelling (for example in the use of *ceteris paribus*) was the hallmark of those for whom supply and demand had moved from being problematic to being helpful.

### **Past examination papers**

We were interested in past examination papers for two reasons. First, the questions set would provide us with an indication of what lecturers wanted students to understand. Of course, dialogue with lecturers about their expectations of students’ answers would have served our purposes even better, but we were able to review the questions in the light of lecturers’ responses to the problems exemplified in the previous section. We reviewed the questions in four past papers from universities C and D and concluded that all but two questions required the deployment of at least three concepts that we were considering as potential threshold concepts. Also, in terms of the distinction made in tables 1, a good answer required use of at least one discipline threshold as well as basic thresholds. In the forty examination questions the most commonly required concepts were: partial equilibrium (21); marginal analysis (18); construction and testing of economic models (14); cumulative causation (14); real/nominal distinction (14); interactions between markets (9); elasticity (9); and opportunity cost (8). Frequency of occurrence is only a partial indicator of transformative potential, but it does suggest that an idea is highly integrated in a way of thinking in a subject.

Second, we wanted to check whether there was any evidence of students' understanding of particular concepts facilitating a more wide ranging and integrated answer to the question. On reviewing students' answers we found there was a tendency towards a bi-polar distribution such that a large proportion of students fell into the category either of using (rather than ignoring or simply mentioning) no putative threshold concepts or of using several putative threshold concepts in the same answer. There was also some evidence that even strong students were not fully appreciating the powerfulness of these concepts, using them appropriately in some contexts and missing them in others, both between and within questions. For example, in a question on traffic congestion from University D, the better students all referred to marginality in considering marginal cost and marginal benefit. However the same students did not use the concept of the margin in discussing the how externalities arose, perhaps indicating the troublesome nature of such a concept.

## **Conclusion**

Through this analysis we have arrived at a depiction of threshold concepts, but these should be seen as a very provisional judgement. We have secured reasonable agreement within our project team, but there is still plenty of debate to be had even within this small group.

More significantly we feel we have developed a way of thinking about threshold concepts that positions the idea reasonably in relation to the existing literature. This is important, because we need to establish whether threshold concepts are a distinct addition to the literature or no more than another way of viewing a familiar idea. The distinction between basic, discipline and modelling thresholds places the idea within the literature on conceptual change, identifying the emphasis on transformation of discipline knowledge as the key distinctive contribution. This also leads to a distinctive way of identifying these 'discipline threshold': focusing on key shifts in thinking in the history of the discipline.

The distinction between basic, discipline and modelling thresholds also offers a more fine-grained set of implications for teaching than viewing all threshold concepts as equivalent entities. The key issue with 'basic thresholds' is the relationship between learners' everyday understanding and the distinctions suggested by the discipline. This is familiar territory in the conceptual change literature, but it is not something that has been taken up strongly in economics teaching in higher education. The implications of 'discipline thresholds' are rather different. The analysis of experts in economics is characterised by an integrated understanding that draws in a range of concepts in making sense of a particular problem. In themselves these concepts may not be very elaborate (e.g. opportunity cost), but they gain explanatory power – their usefulness is transformed- when used in conjunction with the discipline thresholds. Finally we have modelling thresholds that are deeply embedded in the process of reasoning taken for granted in the discipline. These thresholds dictate the direction in which analysis is pursued. Students may understand how a model works, but not what it took to generate the model. If they do not understand the modelling threshold that were used to develop

theory then their ability to adopt the ways of thinking and practice' in a subject is seriously impaired

We believe, therefore, that threshold concepts are a useful addition to the ways of thinking about teaching and learning in Higher Education. Over the next year the ETC project will be developing and implementing teaching strategies designed to increase the likelihood that students will acquire each of these thresholds in first year economics.

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