

Trajectories of students' learning: threshold concepts and subject learning careers

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Abstract

Threshold concepts provide a fruitful way of revisiting the notion of 'learning careers' (Bloomer and Hodkinson, 2000; Bloomer, 2001) in the context of students' acquisition of the ways of thinking and practising of a particular discipline (McCune and Hounsell, 2005). Most students in Higher Education are following courses of study that induct them into the practices of a particular discipline, field or profession. The social context of their learning is framed by their experience of the particular academic community with which they are engaging. They are 'learning biology' or 'learning to nurse'. Threshold concepts (Meyer and Land, 2005) offer a helpful way of characterising the trajectories of students' experience of learning in these contexts.

Meyer and Land (2005) suggest that within each discipline, field or profession there are threshold concepts which integrate and define the scope of the academic community with which a student is engaging. We suggest that students' progress towards a deepening engagement with these communities: (1) the early stages of a subject learning career involve the acquisition of 'building blocks' which at that stage cannot be understood in the way that a master of the subject would understand them, because the learner has not yet acquired the relevant threshold concepts; (2) as students become aware of threshold concepts they face a major stage in their subject learning career, since acquisition of a threshold concept will help students to integrate and reinterpret their previous learning; (3) as students meet further threshold concepts these in turn may transform their understanding of threshold concepts they have previously acquired. Students' responses to these different aspects of their subject learning career may have profound implications for their progress and achievement.

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Introduction

Research on the structure of the outcomes of learning (e.g. Biggs and Collis, 1982; Marton and Pong, 2005) tends to abstract from social context. The focus is upon ‘ways of thinking’. Conversely, research focused on the social context of learning (e.g. Bloomer and Hodkinson 2000, Lea 2005) tends to eschew reference to the outcomes of learning. Concern here centres on ‘ways of practising’. When the spotlight falls on ‘ways of thinking’ progression in students’ learning tends to be described in terms of disembodied conceptions. Students progress in so far as they experience conceptual change. When the spotlight falls on ‘ways of practising’ progression in students’ learning is described in terms of social relations and the configuration of life experiences. Students progress in so far as they are able to access opportunities for learning that help them to make sense of their social experience, and therefore their identity, at each point in their life. A standard practice in the existing literature (e.g. Bloomer 2001) is to emphasise the fruitfulness of one of these perspectives by contrasting it with the other. In contrast, we aim to show the benefits from regarding these perspectives as complementary.

To achieve this we must first develop a justification for this departure from standard practice. A point made by Bloomer (2001 p. 429) provides an appropriate starting point. He argues (2001, p. 429) that ‘a theory of learning must have lateral and temporal ‘connectivity’. That is to say, it must be informed by an understanding, firstly of how learning connects (laterally) with context and with the life experiences of the learner(s) concerned and, secondly, of how one set of learning experiences connects (temporarily) with others that precede or follow it’. From the perspective of ‘ways of practising’ this description of a trajectory of learning focuses on the *social context* for learning. Perspectives of this trajectory in terms of ‘ways of thinking’ may equally emphasise students’ experience. However, now the emphasis is upon variation in the way that the same phenomenon may be experienced due to differences in students’ conceptions. The focus shifts to the *social regulation* of learning in so far as the possible conceptions of a phenomenon are social constructions.

In the first section we develop this argument in a little more detail. We then aim to show how the idea of threshold concepts (Meyer and Land 2005) provides a framework within which these two perspectives can be seen as complementary. Using Bloomer and Hodkinson (2000) as a starting point whilst focusing on disciplinary learning we propose the use of the term ‘subject learning career’ to describe the trajectory of students’ learning within this framework. We then describe how our data were collected and provide an account of the ‘subject learning careers’ of four undergraduate students. These four accounts have been selected from forty-eight semi-structured interviews that were conducted with students of economics at four universities participating in the ‘Embedding threshold concepts in first year undergraduate economics’ project. This project

was funded by the Higher Education Funding Council for England through its Fund for Teaching and Learning scheme. We conclude with a discussion of the results and some implications for teaching.

The limitations of separating 'Ways of Thinking' from 'Ways of Practising'

We associate 'ways of thinking' with conceptions of phenomena that students are expected to engage with in higher education. Phenomenography and, more recently, variation theory provide ways of describing differences in conceptions and the pedagogic processes that are likely to give students access to more complex conceptions (Marton and Pong 2005). However, the focus on the individual learner in this perspective limits its capacity to fully capture 'ways of thinking' in relation to a discipline. First, it tends to neglect relationships between conceptions of different phenomena. Disciplines and fields of study lay claim to some coherence on the basis that the conceptions they foster provide a way of viewing a whole range of phenomena. Second, the characterisation of understanding as a relationship between a learner and a phenomenon misses relationships between the individual and others and between others and the phenomenon. Both these points emphasise the social context of learning. Coherence and disputes within a discipline or field of study are products of a community of scholars over a long period of time. Learners have to negotiate relationships with these communities and the ways of understanding that have been developed by these communities. When 'ways of understanding' are placed in this social context they are juxtaposed with 'ways of practising'. On the one hand the ways of understanding are outcomes of academic practices and familiarity with these practices is a pre-requisite for gaining access to these ways of understanding. On the other hand, relationships between learners and academics are informed by social norms and assumptions that govern the scope for learners to gain access to the practices of the community.

Bloomer and Hodkinson (2000) use the term 'learning career' to describe the trajectory of an individual's disposition towards learning, their engagement with learning and the meanings they ascribe to that engagement. They stress the role of transformations in these dispositions, engagements and meanings and they contrast this perspective with 'notions of fixed personal styles, traits or schemata' (p. 595). Their aim is to position understanding of students' learning in the context the history of students' life experiences and the social, economic and cultural processes and structures that help to shape those experiences. Consequently, for Bloomer and Hodkinson, 'Learning is tightly bound up with matters of identity and situation and cannot be extracted from them' (p. 595). They also stress that learning careers are often 'erratic' (p. 593) and that particular transformations are unique (p. 596).

Arguably, this presents a rather one sided view of the social construction of learning. That is, it stresses the social *context* for learning but pays little attention to the social *regulation* that determines what counts as 'learning'. The infinite variety

of interplay in social relations may make it legitimate to regard the context of transformation for each learner as unique. In that sense, the meaning of the transformation has a unique set of reference points for that individual. However, to categorise any transformation as learning means it must have legitimacy in the context of a community. Since communities derive their coherence from particular ways of thinking and practising they regulate the extent to which a transformation can be regarded as learning.

The idea of ‘communities of practice’ (Lave and Wenger 1991, Wenger 1998) provides a useful standpoint from which to view the social regulation of learning. According to Barab and Duffy (2000) this perspective treats participation in practice as *constituting* learning and understanding. One consequence of this perspective is that progress in learning becomes synonymous with progress in the depth of participation in a community and a learning trajectory is observed in the passage from being an outsider to becoming an insider. The learner is developing an identity as a member of a community. However, Wenger (1998) treats participation as forming only part of practice. He defines practice as a dialectic relationship between participation and the signs and discourse that reify the activity of participation. ‘Reification’ is used here to denote ways in which signs and discourse objectify meaning. Successful learners become more skilful in participating in the activity of the community. They also become more adept at interpreting behaviours, language and other representations in the ways that are taken for granted in the community. They also become familiar with the community’s stories and become enculturated into its taken for granted values and assumptions. On this definition a learner’s trajectory can be traced in each of three related dimensions: participation, interpretation of signs and familiarity with discourse.

Whilst Wenger recognises that reification can be associated with shallow and misleading representations of experience his account presents signs and discourse as essential and fundamentally constructive. This benign view is not shared by others. Barab and Duffy (2000) assert that reification in formal education frequently commodifies knowledge, turning it into “something to be acquired.” That is, reified knowledge only serves a credentialist purpose: familiarity with the signs and discourse of an academic community is a passport to participation in other communities in which those particular signs and discourse have no function. This argument is most usually expressed in terms of cultural capital (Bourdieu 1986). Education performs a function of cultural reproduction and preservation of power relations: an argument that has been used to explain variation in students’ choice of institution (Reay et al., 2001) and retention rates in higher education (Longden 2004). Lea (2005, p.193) goes one step further: ‘It could also be argued that most university teaching and learning practices are not about inclusion but tend to position undergraduate students as permanent novices, never attaining full membership of an academic community of practice’. According to this view, reified knowledge does not even serve a purpose within the community itself, save for preserving power relationships between insiders and outsiders.

The argument here concerns the extent to which reification within academic communities serves a function and the extent to which teaching provides students with access to that reification. The wage premium to 'A' level mathematics (Dolton and Vignoles 2002) suggests that, for this subject at least, familiarity with reified knowledge is valued in the workplace. Why else would 'A' level mathematics (in comparison to 'A' level Physics or History) secure a premium? Dahlgren's (1984) investigation of graduates' understanding of price did suggest that some students now experienced every day events in ways that reflected acquisition of reified knowledge. But whether these examples are exceptions or the norm is not the issue. They indicate the possibility that reified knowledge may be functional beyond formal education. If that is so, the task of teaching is to make this outcome more likely.

Threshold Concepts and subject learning careers

Meyer and Land's (2005) notion of threshold concepts provides a framework for articulating what it means to regard 'ways of thinking and practising' (McCune and Hounsell 2005) as complementary. The threshold concept idea combines an account of the structure of the outcomes of learning with an account of the journey that learner's experience and the way in which their identity may be transformed through conceptual change. In the terms that we have used to describe Wenger's 'communities of practice', threshold concepts provide the driving force for the big stories in each academic community. Meyer and Land (2005) suggest that these threshold concepts usually have five characteristics. First they are transformative. It is interesting to note that Bloomer and Hodkinson make considerable use of this term in describing key moments in an individual's learning career. The difference between the two uses of the term is that whereas Bloomer and Hodkinson concentrate on the individual's orientation towards formal learning per se, Meyer and Land concentrate on the individual's orientation towards a particular academic or professional community. Within this perspective students are not just learning, they are learning biology or learning to nurse. However, the idea that there may be key moments in the trajectory of learning which transform the learner's identity is common to both perspectives. Meyer and Land use the image of a portal to describe such moments. This is significant because the portal is shaped by the academic or professional community. It is the product of a particular history of practice and scholarship. However, its appearance to any one learner depends on the experiences and thinking with which they arrive at the portal. Experiences of the threshold, the moment of passing through the portal (or liminality in Meyer and Land's terms) and pre-liminal experiences on approaching the threshold will vary from individual to individual.

Meyer and Land (2005) suggest that a second characteristic of a threshold concept is that it is integrative and this explains why the portal is shaped by the academic community. The threshold concept is an organising concept which gives shape and rationale to other ideas used by that community. As a result, threshold

concepts are also likely to set the boundaries to thinking in a community and to be troublesome for a learner. Finally, once learners have passed through a portal and begun to embed a threshold concept in their thinking they are unlikely to be able to retrace their steps to where they were before.

Davies and Mangan (2007) suggest two additions to the notion of threshold concepts based on their analysis of students' thinking in economics. First, they suggest a threefold distinction between types of conceptual change as suggested in Table 1. They argue that the discipline thresholds identified in row 2 are bound together with the procedural thresholds suggested in row 3. That is, understanding of the big integrating ideas in a discipline cannot be disentangled from the procedures that are used to generate those ideas. This might be expressed terms used by Wenger (1998). The discipline thresholds generate the powerful narratives or stories that bring coherence to the discourse of the community. The practice of the community consists in the narration of these powerful stories, generating new knowledge in line with these stories, testing the legitimacy of claims within the community for new knowledge, and challenging the legitimacy of the powerful stories themselves. This practice is conducted using the procedural thresholds which legitimate certain ways of doing things. Consequently, a learner's trajectory depends on becoming aware of the nature *and rationale* for taken for granted practices within the community.

Second, Davies and Mangan suggest that it useful to think of the threshold concepts within a discipline as forming an interconnected web. When a learner passes through the portal of one threshold concept this should lead to a reworking of their understanding of any other threshold concepts that have been previously incorporated in their thinking. This might lead them to thinking that another threshold concept was more or less powerful than they had previously imagined. Thus, the more powerful experiences in a learner's trajectory are likely to involve successively more extensively integration of their thinking.

Following Davies (2006) we therefore propose to review evidence of students' thinking in terms of a 'subject learning career'. There are two kinds of integration in which we are particularly interested: the extent to which learners are aiming to integrate their use of 'basic concepts' (row 1 in Table 1) into their thinking about their everyday experiences and the extent to which they are integrating their use of different ideas in economics through threshold concepts. We are also interested in the role played by students' thinking about the procedures used by economics (largely the techniques of theory building) in the development of more integrated ways of thinking.

Method

The second part of the paper presents evidence selected from forty seven semi-structured interviews with first year undergraduate students who were taking an economics module. These data were gathered from four English universities

participating in an FDTL5 project ¹, largely in the latter half of the second semester. University B was a high ranking ‘old’ university whilst the other three were post- 1992 institutions. Students were selected to provide a range of previous and current experience. The sample included variation according to prior experience of studying economics and whether the student was enrolled on an economics award as well as variation by gender and average level of prior achievement. Each interview lasted approximately 30 minutes.

The broad structure for each interview was informed by data collected during the previous year of the project. These data suggested that students’ experiences of learning a subject could be described in terms of the development of a subject learning career (Davies, 2006). Thus the interviews aimed to explore the students’ initial experience of the subject, the extent to which they regarded their learning of the subject as related to their own economic experience and their experience of developing a more integrated understanding of the subject. They were encouraged to focus on experiences that they believed had acted as spurs or barriers to their progress. In order to avoid prompting responses that would ‘fit’ our developing ideas about threshold concepts, the questions avoided the use of the word integrative.

Four different members of the FDTL5 team undertook the interviews which were taped and subsequently transcribed. The interviews were then analysed using Nvivo. The coding for this analysis drew on three types of conceptual change identified in Davies and Mangan (2007, forthcoming), four conceptually distinct modes of variation in students’ learning engagement of threshold concepts identified in Meyer, Land and Davies (2006) and indicators of students’ approach to learning economics.

Findings

In this section we present the stories of four students selected to illustrate some themes that were apparent across our sample. We have chosen to concentrate on just a few students in order to convey something of the pattern in their experience. Since the emphasis in our analysis is fixed on ‘subject learning histories’ we need space to convey a longitudinal perspective on students’ experience. Brief extracts selected from a large number of interviews would not convey the links and discontinuities in students’ experience over time.

Student A2

This student had studied economics at A level and initially found it difficult and confusing.

¹ The Embedding Threshold Concepts in First-Year Undergraduate Economics Project is based at Staffordshire University, UK. The project is funded by the Higher Education Funding Council for England and the Department for Employment and Learning (DEL) under the Fund for the Development of Teaching and Learning.

'It was at AS level. I never really encountered it before say it just seems really difficult in the first year with all these diagrams and it's just really confusing. For the first few months it really was confusing. It got really hard ...but then it got easier as it goes along. The more you learn it gets easier, because it all links together.'

'.....in economics it's like you just get diagrams it's just D and S on it and I didn't know what it was. I didn't understand what it meant or showed, until it got explained. And then all the other diagrams, well, got the long run cost...cost curves and stuff like that. It got really confusing, there's too many lines there. I just didn't know what each one meant exactly until you got to know it better and do it more and more.'

He recalled graphs as central to his initial experience of the subject and described his learning in terms of working out the meaning of the diagrams. However he appears to regard the graphs as fixed representations rather than a process of theorising. Although he describes his increase in understanding in terms of 'links together' it is not clear from these extracts whether he is making any such connection. His account of graphs appears to be fixed on the outcomes rather than the process of economic modelling.

He went on to describe his achievement during A level economics at school in terms of learning to become comfortable with diagrams in economics, regarding them as useful representations of real world phenomena:

'Yes, they represent the real world in some sort of way or another. It's better than some of the definition it shows that a lot easier. So I prefer to draw a diagram rather than write a definition.'

He used the phrase 'links together' repeatedly to try to explain his experience at school and his transition to studying economics at university:

'What helped me learn actually macro really well at A level was when I did a target two competition, a Bank of England competition where I had to actually act as the MPC and decide what to set the interest rate as ...and that helped as I actually had to intensely learn how to do it, especially as I was like the team captain so I had to do most of the work. So I had to really learn all the.....how everything links together and that and that really helped me learn how macro works.....'

'everything sort of links to other things so to learn all the other concepts you have to know the core concepts first really wellto understand the other bits better, butthat's all. Not sure really...'

When asked to provide an example of this linking together he asserted that everything in macroeconomics is connected to inflation and when asked how he made a potentially interesting connection to international trade, but did not offer a thread of reasoning to follow this through.

'Let's put it to you more like, competitiveness on a global scale, it just shows howthe country's growing or progressing. I'm not sure I know.'

Asked to choose a concept that had been difficult to understand, he chose an advanced topic at level 1 that required an understanding of economic modelling and the threshold concepts of cumulative causation and interactions between markets, returning to the diagram being the key to his difficulties.

'I think the hardest topic I found is the ISLM.... just because there's so many different diagrams to go through that it just seems really difficult to go through them and find a logical process for it.'

Under further questioning he could not elaborate on what was the point of the ISLM framework. He saw his failure on the IS/LM model in part of a test as important in his learning process because it would then stick in his mind. However, when asked whether his uncertainty over IS/LM might cause him problems next year he replied:

I'll probably know that.....I'm going to expect it to be a lot harder, so I'll probably revise harder for it and try and learn it a lot better and erm... I'll probably try and learn the diagram a lot better as well because once I look at a diagram it kind of helps you learn it because I've sort of got, sort of a photographic memory to try and remember a diagram. I like to.....if I just stare at the diagram I'll remember it, so that's the way I usually revise as well. I'll draw a big diagram and stick a it on my wall and leave it there and then I'll just keep.....I'll end up looking at it.

Yes. It gives it.....the problem I usually have is knowing which curve goes where and the theory, it can be difficult but once I know which way the curve....direction of the curve goes I'll get the theory from it.

He aims to memorise the diagrams, but does appreciate that these are not the end point. He reiterated several times that doing this helped him understand the theory. But as the diagrams become more complex his response is to work harder at using the strategy that served him well at A level. It appears that his overall sense that 'everything in economics is linked together' is weakly operationalised. This may be related to the way he is trying to learn graphs as finished products of a modelling process rather than trying to think in terms of theorising that leads to representing the world through graphs.

This student had reached a point in his journey where he felt its use his understanding in entering into economic discourse, but not his personal decisions:

...it has helped me in like, say when I'm watching the news or something like that and they have an economics report. I understand it now, whereas before it just....I wouldn't bother watching it because it just seems rubbish, there's just nothing there to understand, but now I understand it a lot more and what they're trying to say and why people are making those decisions. But in my own decisions it's not really changed what I used to do before.

When asked to give an example, the student mentioned particular areas of the news, but was unable to name particular concepts had helped in his understanding.

It's more like everything in general really, just that I understand it better. It's nothing in particular, it's more the general theory that helps me learn it, or understand it.

Asked if there were any critical or memorable moments in his experience, the student went back to his A level experience and the participation in a Bank of England competition, stressing how this helped link things together and was better method of learning than the text. He also expressed how it was easier to learn if he could find personal relevance.

I find it easier the way that...such of [lecturer's name] does. I love the way he teaches because he relates it to other things that I enjoy because he likes football a lot, so he relates a lot of the theory to football, so I found it a lot easier because I like football as well. So, it's related to stuff like real world situations that I like, and I found it a lot easier.

In his initial experience of economics this student was confronting two aspects of economic thinking: basic concepts (as illustrated for example in the idea of a cost curve or inflation) and procedural concepts (such as equilibrium and elasticity) that are referred to in the exposition of diagrams in introductory economics. To some extent he had accepted some pre-requisites for seeing the world as an economist: regarding graphs with intersecting curves as a reasonable way of describing the world and believing that the ideas in the subject are somehow interlinked. However, his approach to graphs ('if I just stare at the diagram I'll remember it') gives little scope for developing an understanding of the power of procedural concepts in modelling and we might expect this to act as a brake on the development of this student's understanding. The strategies that worked adequately at A level are not sufficient to support the development of understanding of threshold concepts. Although the student has a belief in economic ideas linking together he struggles to bring this idea to bear on his practice.

Student B6

This student referred to parents as influential in his initial experience of experience. He indicated that both parents were interested in economics, although they had not as pushing him towards the subject. He had completed A level economics and reported an immediate affinity to the subject.

I liked how like you like can apply a theory to real world applications. I like how it's quite numerical.

Nevertheless, when compared with Student A2 this student's account of the transition from school to university suggests more of a transformation in his understanding of what it means to learn economics.

'At A level I think we all assumed that we all thought like economists and like it was very straightforward whereas now that we have started doing the macro we saw that with A level they had glossed over a lot of things and also at A level there was like just one way of looking at economics whereas now we have been introduced to the different schools of thought. Just making it more interesting I think.'

'Because at A level we kind of took the aggregate demand and aggregate supply like a given and like a group built from that. Whereas so far this term we have been working on the derivation of like aggregate demand and aggregate supply from IS/LM and it has been quite interesting to see how at A level whilst we thought like we knew everything they were glossing over a lot of the assumptions and theory.'

In contrasting his school and university experiences he uses the terms 'assumptions', 'theory' and 'derivation'. He locates his new way of thinking by

reference a focus on theory creation through the use of procedural concepts. He now looks back on his understanding at A level as more simplistic.

His view of learning economics was also reflected in his description of his actions when he was unsure of an idea that had been presented:

Well, I normally, if there is something that I am not 100% on, I go away, put my lecture notes to one side and then take out the text book and like make notes from it and try and convince myself and try and teach myself from the text book and then once I am happy with that I go back to the lecture notes and go through those and if I'm completely happy with those then I will assume that I have learnt it okay.

The phrase 'teach myself' suggests an approach that is very different from student A2 ('I just stare at the diagram I'll remember it'). There is an indication that student B6 believes they can follow the rules of reasoning that characterise thinking in the subject (they can use relevant procedural concepts) whilst student A2 relies on remembering the outcomes of reasoning. So whilst, like student A2 he referred to the development of his understanding in terms of increasing his awareness of interlinkages, he was able to exemplify this idea by referring to theoretical ideas and his awareness of newsworthy economic phenomena.

'It's like aggregate demand and supply, erm...I found it interesting like one of our questions recently was looking at liquidity traps and then whilst it was interesting it was made more interesting by the fact that we could apply it to like Japan in like the 90s and so bringing in like a real world case study makes it more interesting.'

'Like something like the revaluation of the Chinese currency and how by having a fixed currency they are exacerbating the US current account deficit.'

He explained that he engaged in discussion with friends about such economic issues and expressed a commitment to the usefulness of economic thought. He felt the subject was undervalued and could be used to solve real world issues. When prompted he offered an example.

Well for something like maybe Geography or the environment like the green people would say that there should be no pollution at all. Whereas environmental economics would say that there is a sustainable level of pollution and we should pollute up to the point where the costs and benefits equal each other. So I think that economics presents a much more practical way of thinking than some other disciplines.

This student explicitly argued that he had changed his understanding of what it means to think like an economist. They are also able to back up their view that increasing understanding in economics is about linking ideas through examples that would be recognisable to a practising economist. In describing their understanding of IS/LM this student provides evidence of an understanding of interaction between markets, which has been suggested as a threshold concept. There is a correlation here between using a threshold concept, awareness of the role of procedural concepts in modelling, transforming understanding of basic concepts in the subject and transforming understanding of what it means to think like a practising member of the community.

Student B1

Although studying at the same university as Student B6, the experience of Student B1 was quite different. He chose to study economics at school because 'he couldn't think of anything else to do', but he enjoyed the subject and achieved a high grade in the final examination. However, his attitude to economics has now changed.

Umm...I don't know, I really, (at school) I just... enjoyed sort of, I thought it was pretty relevant to the world actually when I first time doing it. Anyway, I've become a little bit disenchanted with it now, but at that time really... I can't really say ...a sort of intuitive feel really, to start with.

At university he was reading politics Philosophy and Economics and had assumed that the economics part of his award would be easy. However he had encountered problems within a few weeks and was concerned with complications and was not enjoying or engaging with the subject.

...I don't know. I just think since I got to University its become its become a bit more complicated really...erm...I can't really say, but I just think it's sort of the way they explain the... it just gives it more confusion sometimes. Stuff like, it seems not much difference between what we're doing this year, what we were doing last year, but the ways it's being explained is so different that I just don't get it. So, some of the time I think that in lectures that I can keep on to points in your depth then they move on to something more complicated. I mean, I should know anyway because I did last year, you know but things do come and go out of your mind don't they? I am really struggling with this year, I really am.

He was asked of an example of his problem and he voiced his confusion over an area covered in that week's seminar on aggregate demand and supply.

I mean even just like today we were doing about aggregate demand and aggregate supply and I had no problems with that last year but we're.... with bringing in sort of terms and stuff that I just don't understand like just one of the questions today ..erm ... I can't think of it exactly...it was sort what makes up aggregate demand and I just thought of the consumption, government spending, taxation, it was something completely out there that I had no idea what that was, you know. It's just going to get what I learnt last year, well, the last two years really, I just don't quite get it this year. That's like my fault as well, my lack of concentration perhaps but....

This student was experiencing problems because lecturers were asking him to think about a familiar category (aggregate demand) in a new way. But he was, so far, unable to position this new conception in relation to his previous understanding. To him it was 'something out there' wrapped in complexities. His reaction, that of going back to his familiar conception, was not helping. Further questioning suggested that the lecturer taking this seminar was intending students to think of aggregate demand in terms of money as well as in terms of goods whereas the student's previous teaching had developed a conception of aggregate demand purely in terms of goods. It appears that this student did not have a broad idea of where the lecturer was trying to take the development of his understanding, which we might describe in terms of Table 1 as working towards an understanding of interaction between markets (in this case the goods market and the money market).

Further evidence of the reasons for the problems being faced by this student is provided by his own diagnosis of whether his difficulties lay in understanding the ideas or the way the ideas were represented.

I don't have much problem with the actual ideas, as such. Certainly the amount of graphs that are just put up with sort of minimal explanation. You go to lectures and there'll be graph after graph after graph, all these lines going everywhere. Just like last year, I'd just be doing the aggregate demand and that would be it ...just one shift in the curve ... there's all these lines.... how you are meant to draw some of the graphs I'll never know. You see them sort of done on computers, that's fair enough, but to actually have to draw them ...there is something like ten or twelve lines on them. I just don't get what's going on.

When questioned on what he saw in these graphs, his reply was simply 'nothing'. The diagrams are simply complex drawings to him, rather than representation of the theory based on certain modelling processes. At A level he was able to proceed on this basis, but at university the increasing depth was revealing the problems with this approach. To this extent his interpretation of his experience is somewhat similar to student A2. Both (A2 and B1) students saw graphs in economics as an embodiment of a perceived reality rather than theorising in process. This can be seen in a comment by student B1 about the difficulties he experienced in interpreting textbooks.

They tend to be all different, I mean...just a simple thing when sometimes the curves on the graphs are straight lines, sometimes they're curved lines, and it's just like, you go to different book it'll be a different diagram. There's no sort of consistency with what it is.

When asked if there was any event in the world he could understand better with his economics, no examples were forthcoming. To probe this further the interviewer presented a recent news story that had attracted controversy: should an expensive new treatment for cancer be provided free through the NHS. There was little evidence in his answer of a willingness to allow economic analysis to intrude on his conception of the problem. He concluded with the view that

perhaps would argue Government should provide these drugs no matter what the cost of them if they are going to save these women...

Student B1 had achieved a similar grade to Student B6 in their economics at school and yet their experience of the same teaching at university was radically different. Whilst Student B6 had embraced the invitation to re-conceptualise what had been learned at school this student resisted. It may be that this resistance was framed by their stated expectation that the economics in their university course would be the 'easy part' since they had studied the subject before. However, there are also suggestions of some deep-seated problems that are hindering this student's capacity to progress on a learning career in economics. In particular, (1) this student expects the graphical representation of theory in economics to depict economic phenomena rather than show a way of theorising the possible behaviour of economic behaviour (2) there was little evidence that this student was actively seeking ways of trying to use their economics to make sense of their experience and (3) they interpreted an expectation by lecturers that they should re-

work previous ideas they had learned in economics as problematic rather than an indicator of the direction their learning should follow. On each of these points there is a strong contrast with Student B6 and this may explain why there is no indication that this student is even approaching an understanding of the threshold concepts that are emerging in Student B6's thinking. We may also contrast Student B1 with Student A2. To some extent, Student A2 shares the first problem. They also appear to see graphs as received theory rather than a way of theorising. However, Student A2 is actively seeking to embed their emerging understanding of economics in their experience and they see themselves as on a journey which will increasingly link their ideas. There is little impression in Student B1's account of awareness of being on a journey.

Student D8

This student expressed an initial life orientation towards the subject, with encouragement from his father and his own curiosity.

I guess it was like on the tube really, when people are reading the Financial Times, I just thought... why a special paper about economics and financial business so I thought I'd ask my father and his mates and they sort of explained to me about shares and options and stuff and people making money from markets and that sounded quite interesting. So I thought, oh I'll give it a go studying economics really.

However it was a second best option. He had originally planned on studying Physics and Mathematics and he had not taken economics before university.

... my physics teacher told me that I wasn't a physicist (laughs). So I went like, okay, fair enough and so I had to go with economics really.

He described the transition from school to university as difficult due to the quantity of new ideas, but did see himself as starting to progress within the subject as he as beginning to see patterns emerge within the subject.

It's been difficult I must say and it wasn't what I expected, lots of concepts, lots of ideas but if you keep working at it you begin to see some patterns generally for economics which I am sort of just beginning to see at the moment. The first few days were a bit, the last few months were a bit sort of hectic ...because I didn't study economics before, so everything's quite new.

This student was able when asked to pursue how he saw patterns, relating to aspects of economic modelling (an understanding of the role of equilibrium) and basic concepts that link directly into a threshold concept (marginal costs).

Yeah, yeah, not just supply and demand but sort of the idea where the two lines meet, so that's your the equilibrium point, it seems to be where the market seems to either be heading towards, so the pressures there seem to be pushing sort of along the line up to that point or bring it down to that point depending where you are in the market and seems to be doing different things to get to the equilibrium point really. It's not just...supply and demand was the first thing that hit me but you can see that in also like marginal costs and ... things like in the flow of money and stuff or there's like, I'm not very good at it, there's income and taxation and stuff, all those kind of lines meeting and stuff and you can see how forces of the market try and sort of interact and try and push them where they meet and stuff, changes and stuff. I'm not making much sense I don't think, it's too early in the morning for this.

The language of this accounts of graphs contrasts sharply with the accounts given by Students A2 and B1. Where they speak of (fixed) lines this student sees something more active. Student D8 speaks of 'pressures', 'movement', 'forces' and critically of equilibrium (identified as procedural conceptual change in Table 1). They have accepted the underlying way of theorising: 'forces of the market try and interact and push them to where they meet'. This student attributed their approach to graphs to some advice from a lecturer: draw the diagram, try and understand the story behind it and what would happen if something changed. The final piece of advice 'what would happen if something changed' is particularly telling in terms of understanding the diagram as a way of theorising. Asked if he found the advice useful the student replied:

Yeah... yeah found it sort of sometimes when you just read a textbook so it just washes over you and you think yeah I understand it and then you get to the exam and its like wow, what's going on but if you like try and sort of see what's happening within sort of your model and like how changes like affect the model then and you sort of get a better sort of grasp of the idea, of what's going on. That's the plan anyway, I don't really do it too much as I'm not sleeping or eating at the moment but when I do get to study that's what I try and do.

He was able to describe a personal approach he had developed to using graphs in this active way:

.....the first one you draw (following textbook versions) has no numbers, just what it is really and then obviously afterwards then you start to make changes and stuff and see what, it's easier to see what happens when you have numbers rather than when you don't because the line changes, You don't really know where its going like, it moves up and how much it affects it, whereas if you have a number and it has an increase by a percentage...

It was interesting to note that this well developed approach to key procedural concepts in economics had developed so early in his studies at a time when he was being introduced to a raft of basic concepts (as in Table 1) with which he was only gradually becoming conversant. This was evident in a number of responses in the interview and he was open about his experience in becoming familiar with these basic concepts.

.....I got it and then I lost it and then I sort of got it again but now I'm completely, you know.....

But, like student A2 he had also developed a belief in an underlying pattern in his learning of economics. He stressed that patterns, how things linked together, and overviews were important to his understanding.

Yes. A lot, and that sort of.....they.....I think there's a common theme running through it. I can't put my finger on it yet and I'm not sort of.....don't know what's happening. Why.....what effect....sort of if you take a step back and look at it you can kind of see that there is something which is generally running through.

As with Student A2 his sense that something was holding things together predated his ability to express how that 'holding together' was being achieved. He expressed this uncertainty even though his account of the modelling process in relation to markets was strong for a student in the early stages of his study. His

emerging belief in a pattern in economic thought also appeared to be informing his attempts to use economics in making sense of the world.

Just my overview, sort of general overview of life really, I think major economics made major changes, so if you sort of just look out the window and sort of, instead of sort of generally sort of seeing mess, that's the problem. How am I going to fix that problem? What I need to do....see that's another I need to fix sort of what do I have to do to make sure that I get there and finish it and put it down. I don't know if that's just the economics or studying but I find that economics helps sort of....you see a problem, you have to model and then try and predict what's going to happen and then you sort of have your solution, and I think that's quite helpful in general. See you have a problem and you need to do something. You have the sort of options you need to consider around doing and do it and then you have some solutions after that and I think generally that's sort of how I try to think outside economics.

Student D8 is not facing any of the three problems hindering Student B1's learning journey in economics. He sees graphs as a way of theorising, he is expecting to use economics in the way he makes sense of the world and he has a belief in pattern to his learning that his generating a sense of forward momentum. We might expect that this student will progress towards the kind of understanding developed by Student B6 at a faster rate than Student A2 on the basis of his understanding of graphs as a way of theorising.

Conclusions and Implications for pedagogy

We have reviewed evidence of students' thinking in terms of a 'subject learning career'. All but one of the considered above students were attempting to engage with the community, although we would only consider one to be fully successful at this point in their careers. In order to progress at all in economics students need to develop a good understanding of the procedures of economic modelling (Shanahan, 2006). The use of these 'ways of practicing' is intertwined with the development of understanding of both basic and threshold concepts. Our students showed a large range in their understanding of these procedures. For one the development of economic modelling at university was expanding his horizons. At the other end of the spectrum we found a student who had not started even to appreciate the importance of the modelling procedures in the development of a more integrated way of thinking and this was creating a barrier to any development.

One of our students was clearly beginning to integrate different ideas through acquisition of threshold concepts and this was leading to him to revise his previous understanding. Two recognised the importance of linkages within the subject matter, but their understanding of threshold concepts was undeveloped.

There are various implications for pedagogy that we can draw from our study. The interviews highlight the importance of understanding of economists' procedures for theorising and the connection of this to diagrams. In building up the theory, the end point may be lost to students in the complexities of getting there and making this clear may help their progress. It is important to highlight variation in the use of key procedures and why explain why some features are

important and others are not, why for instance, it does not matter if in certain graphs it does not matter if we use straight line or curves (rather than just explaining when it does matter).

Our students were drawn towards the subject because of its perceived relevance and it would seem important in learning to exploit this and relate to examples of personal relevance. Using applied examples may help in revealing the strengths and limitations of theory and the importance of the interconnections between concepts. Students may need links to be made explicit at this stage in their subject career and opportunities for them to make links both between concepts and to applied examples may help deepen their understanding. It is important to explicitly help students to integrate their understanding. We need to help students to consider integration in their learning, to acquire threshold concepts and use these in reviewing their understanding of previously met concepts. Well designed activities and assessment can play a role in this in making students review their understanding within the framework of a particular task.

We need to provide scaffolding for students to remind them of basic concepts (or indeed introduce some of them) before developing a new theory or application that requires them. Concepts students have previously met in isolation are unlikely to be fully recalled and they need to rework them and revise their previous understandings of these concepts. In a subject where a web of concepts is important, a lack of a sufficient foundation of basic concepts may stop progress towards the acquisition of a threshold concept. A careful development of ideas is needed to provide the required support, both in seminar exercises, and in self managed work, for instance the provision of online materials or specific reading

Students need regard their understanding as provisional and tolerate uncertainty. 'Incomplete' conceptions have to be learnt in order to make more 'complete' conceptions accessible to them. Our interviews highlighted a problem when students do not regard their understanding as provisional and resist further progress. We found that students had given little thought to their own process of learning and found it was a novel experience to be asked about this. Helping students to understand aspects of their learning process may be useful.

The appropriate emphasis to give to each of these pedagogic themes will vary according to where a student is in their subject learning journey.

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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>
1 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.
2 Discipline	Understanding of other subject discipline ideas integrated and transformed through acquisition of theoretical perspective	Partial equilibrium, interaction between markets, welfare economics, opportunity cost
3 Procedural (in the case of economics – how are models of the economy constructed and evaluated?)	Ability to construct discipline specific narratives and arguments transformed through acquisition of ways of practicing.	Comparative statics (equilibrium, ceteris paribus), time (short-term, long-term, expectations), elasticity