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The nature and experience of academic understanding

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The two of us have been reflecting over a number of years about the nature of academic understanding, discussing the research findings and wondering about their implications for education. This paper offers, for further discussion, some of the evidence and ideas underpinning our thinking.

Early explorations of the nature of understanding

The earliest discussions about the nature of understanding came from philosophers, particularly during the Enlightenment in the 1700s, when David Hume's *An Enquiry Concerning Human Understanding* (1748, in Millican, 2007) had widespread influence. Yet his analysis has to be seen in its historical context. It was making a radical attack on the influence of religious teaching on the freedom to speculate about the nature of the world and its inhabitants. Hume's thinking showed the crucial importance of logic and evidence in deciding what conclusions could be reached within human understanding and pointed out its probable limits, and yet he still saw the nature of understanding as elusive.

It is remarkable concerning the operations of the mind, that, though intimately present to us, yet, whenever they become the object of reflection, they seem involved in obscurity; nor can the eye readily find those lines and boundaries, which discriminate and distinguish them. ... It becomes, therefore, no inconsiderable part of science ... to know the different operations of the mind, to separate them from each other, to class them under their proper heads, and to correct all that seeming disorder, in which they lie involved. (Millican, 2007, p. 8-9 of the *Enquiry*).

Research in mainstream psychology

Nowadays, we might expect psychology to have more pertinent answers, but 'understanding' has not been part of the research agenda in mainstream psychology. The early behaviourists, of course, would not consider such an idea, and yet their notions of *arousal* and *reinforcement* do remain relevant to it. Even cognitive psychologists have been wary of exploring the nature of understanding, seeing it as too broad and vague a concept to be operationalised in ways that could be investigated experimentally. There were, however, important studies on memory that led to the notion of *mental representations*, which could be readily accessed from long-term memory (Johnson-Laird, 1983) and have been taken to be

associated with the way in which understanding may be formed and stored. There was also the idea of *mental models* in problem-solving, (Gentner & Stevens, 1983), which was associated with how an understanding is used. None of this research, however, addressed the nature of understanding itself, and yet educationalists consider understanding to be a crucial goal of education, particularly at university level (Kirby & Lawson, 2012). So, what have educational psychologists had to say about it?

Research by educational psychologists

One of the difficulties in discussing the general meaning of ‘understanding’ is that it proves to be multifaceted and used to describe instances of rather different things. For example, it can refer to an end-point or *outcome of learning*, but if we are describing ‘reaching an understanding’, we are focusing on the *processes* involved. When we come to *academic understanding* itself, its meaning will differ depending on who is experiencing it. University teachers may be referring to understanding as a *target* to be achieved, while students are more likely to be describing experiences of reaching their own *personal understanding* (Entwistle & Smith, 2002).

The idea of academic understanding as a target or goal leads to discussions about what form it takes. For example, White and Gunstone (1992, p. 3) suggested six distinguishable targets; the understanding of single elements of knowledge; concepts; extensive communications; whole disciplines; situations; and people. The idea of a target also indicates that understanding is necessarily directed towards an object – we understand something – which also reminds us that in education the object, and the processes used to arrive at the understanding, necessarily differ markedly across subject areas (Donald, 2002). The processes involved in coming to understand, for example, a mathematical equation, a piece of literature or music, or people’s behaviour, are markedly different, even if the feeling of satisfaction achieved may be similar. In academic contexts that satisfaction is, however, often hard won: the student’s learning has to be active and highly focused. Nickerson (1985), in an article on ‘understanding understanding’ commented:

Understanding is an active process. It requires the connecting of facts, the relating of newly acquired information to what is already known, the weaving of bits of knowledge into an integral and cohesive whole. In short, it requires not only having knowledge but also doing something with it... [Nevertheless], all understanding is tenuous and, in a sense, transitory. We are obliged to understand the world in terms of the concepts and theories of our time... At root, understanding is a true paradox: the more one learns, ... the more one ... [becomes] aware of the depth of one’s ignorance. (pp. 217, 234, 236)

Pask (1976) was one of the few educational psychologists of his era who investigated the nature of understanding. He developed a *conversation theory* of learning that saw academic learning as the interaction between two knowledge structures, with the student's structure gradually approaching that of the teacher. In his experiments, students were asked to display their changing views of the inter-relationships among aspects of a topic through elaborate concept maps. Their understandings were then demonstrated by 'teaching back', explaining them to the satisfaction of the teacher or researcher. His work showed the crucial importance of *feedback* – explanations from the expert teacher or computer system - in shaping the development of a student's academic understanding. He also identified individual differences in the processes involved in developing an understanding, contrasting *holists*, who depended on seeing an overview the topic from the start, with *serialists* who used a step-by-step approach in their learning. Students could reach an understanding whichever style they preferred, but following markedly different routes.

More recently, Perkins (1998) criticised the teaching implications of viewing understanding mainly in terms of knowledge structures or mental representations, arguing that a *performance perspective* was preferable, as it emphasized the processes underlying understanding that teachers could then encourage directly through the tasks they set.

Understanding is being able to carry out a variety of actions or 'performances' that show one's grasp of a topic and at the same time advance it... [Our performance perspective is] a brand of constructivism ... because of its emphasis on building learners' repertoires of understanding performances, more than cultivating the construction of representations... Understanding is a matter of being able to do a variety of thought-demanding things with a topic - like explaining, finding evidence and examples, generalizing, analogizing, and representing the topic in a new way... It is being able to take knowledge and use it in new ways. ... (Perkins, & Blythe, 1994: 5; Perkins, 1998: 40, 57)

A well-honed understanding can be put to use and so become *proactive* (Perkins, 2008), supporting future cognitive activity, such as explaining to others, interpreting or applying in new contexts, seeing within a broader perspective, empathizing with others' behaviour, and being aware of one's own thinking in relation to that of others (Wiggins & McTighe, 2005, p. 84). Developing such a proactive understanding has been seen in terms of a *thinking disposition* that involves three main components – *ability*, *willingness*, and *awareness of context* (Perkins & Tishman, 2001). It depends on having acquired the intellectual skills needed and the strategies for using them effectively; a willingness and intention to put effort into applying those skills; and a continuous monitoring of that effort in relation to the

perceived demands of the task. Such awareness of context is also valuable, later on, in seeing how to use understanding in new situations.

More recently, Bereiter (2002) has argued that a definition of understanding has to involve more than the completion of tasks that demand high-level learning processes, as such a description says nothing about its underlying nature. He rejects the idea of mind as a bundle of bits of knowledge that can be brought together to form an understanding, seeing it as just 'folk psychology'. Marton and Booth (1997) saw understanding as a relationship between the learner and the world, not as separate entities but as "*constituted* as an internal relation between them" (p. 13). This idea is also seen in Bereiter's thinking, as he draws on connectionist ideas from neuropsychology to describe understanding as an emergent property of our natural, self-organizing ability to make sense of the world around us.

There is something personal and contingent about understanding ... involving the whole relationship between knower and the object of understanding. ... The connectionist view of mind [sees it] as a self-organizing system - a system that does not actually contain mental objects as data but that produces knowledgeable behavior as an emergent. ... It makes better sense of the mind's relation to brain on one hand and to the physical world on the other, and of the inseparability of thought and feeling. ... Self-organization at the neural level ... produces thought as an emergent. (Bereiter, 2002: Cht 6, final page)

There is growing evidence of the mind acting as a self-organising system with processes that can be mimicked by computer programs, weighting connections between nodes within a neural net to create an emergent output. But, as in almost all attempts to describe understanding, we are left with a metaphor that may or may not accurately represent how we experience understanding.

The crucial difficulty in capturing the nature of academic understanding is that the mental acts leading to that understanding are fleeting and barely conscious. Outsiders can imagine them only through people's explanations of how their understanding came about, what that experience involved and felt like, and how it was subsequently used. Student learning research has systematized the collection of such explanations from a wide variety of students on their study practices to throw more light on the processes involved in reaching and using academic understanding. Often there are a few students who throw a particularly valuable light on the nature of understanding, and extracts from such descriptions will be used in the following section to illuminate the nature of academic understanding. These extracts have been chosen to illustrate the kind of comments that students have made in a wide range of different interview studies.

Student' experiences of understanding

Students generally describe having their own idea of what they are aiming to achieve, however tenuous that goal may initially seem to them. For an understanding to be reached, students have to have the *intention to understand*. That may seem obvious, and yet its importance was rarely recognised in educational research until Marton and his colleagues introduced the notion of deep and surface *approaches to learning* (see Marton & Booth, 1997). The approach depends on an intention, either to seek the deep, underlying meaning, or to rely on surface aspects and avoid personal involvement in the learning. These different intentions inevitably lead to contrasting learning processes. A *deep approach* requires substantial effort in, for example, *relating ideas* and *using evidence*, but each discipline and subject area also requires specific skills and strategies to reach academic understanding (Entwistle, 2009). A *surface approach* may also involve substantial effort, but is directed towards the routine *memorising* of facts and theories, *reproducing* the teachers' knowledge and its structure, and mimicking their understanding.

Discussions about the deep approach led to research in Edinburgh that focused on students' experiences of understanding when revising for final exams. The students typically described an emotionally tinged feeling of arriving at a satisfying picture of ideas and evidence fitting together into a coherent whole (Entwistle & Entwistle, 1997). There was a clear sense of cognitive and emotional aspects being inter-mingled, and understanding being recognized as an event that might occur suddenly, even surprisingly, but at other times gradually and unconsciously.

Understanding is the interconnection of lots of disparate things, ... the feeling that you understand how the whole thing is connected up - you can make sense of it internally... If I don't understand, it's just everything floating about and you can't quite get everything into place - like jigsaw pieces, you know, suddenly they connect and you can see the whole picture... But there is always the feeling you can add more and more and more... [Really understanding], well, for me, it's when I ... could explain it so that I felt satisfied with the explanation... [When you understand like that]... you can't not understand it [afterwards]. You can't 'de-understand' it! (various disciplines in Entwistle & Entwistle, 1997, p.148).

Analysis of the complete set of transcripts from this study identified recurring descriptions of understanding as also involving a sense of *coherence*, *connectedness* and '*provisional wholeness*', a recognition of *meaning and significance*, a sense of *irreversibility* but with a recognition that understanding could be a *continuing process*. There were also feelings involved, related to *closure* and *confidence about explaining*. Findings of

connectedness and personal significance were also reported by Dahlin (1999) among first-year undergraduates, and he also found a developing metacognitive awareness that “seems to progress from an outward-looking, ‘external’ awareness towards a more inclusive awareness, which embraces ‘outer experience’, ‘mental acts’, and the learner as a whole” (p.203).

The Edinburgh research also identified individual differences in the *forms of understanding* that students were seeking, reflecting the *breadth* of information and evidence being integrated, the *depth* to which the interconnections between the ideas were being pursued, and the extent to which a clear *conceptual structure* was found, or created, within which to make sense of the sources used (Entwistle, 1998). However, the ability to develop appropriately academic understandings depends on acquiring the necessary concepts and theories used to create conceptual structures. In the first year of a degree, there are usually some basic technical concepts that have to be mastered and, later, these concepts are integrated into increasingly complex combinations, some of which act as *threshold concepts* that provide a portal into a more advanced level of understanding (Meyer & Land, 2006), but which often prove difficult for students. Eventually, students begin to adopt the ways of thinking and practising that are the hallmark of professional expertise (Davies & Mangan, 2007), and these provide a formidable challenge to students due to their abstract nature.

Academic understanding can then be viewed as a progression through a series of *levels over time* (Dahlin, 1999), with earlier understandings being constantly fine-tuned, or even reformulated, to accommodate the new ideas met. In a study of medical students, Fyrenius, Wirell and Silén, (2007) found that those who were seeking to develop a deep personal understanding at an advanced level developed it through

a continuous restructuring and reframing of facts and knowledge... It seems that [these] students continuously shift between details and wholes, and are simultaneously aware of the overall picture and details, even though their focus is on one of the two... They continuously move between different perspectives and learning modalities in order to reshape and refine [their] understanding... [and] Interestingly, it is not only the number of different [mental] activities that is of importance, but the way the students construct meaning out of the activities. (pp.160-16)

A similar sense of the interplay of evidence and perspectives in forming an understanding was found in a study by Hay (2010), who used a dialogic form of concept mapping with students explaining the meaning of their maps to the researcher. He argued:

From a dialogic position, learners do not come to understand things in isolation, but meanings are shaped through the inter-animation of the different voices (or texts) of others, as students

learn to see things from other perspectives. Here, it is an increasing inclusion of *difference* that leads towards more encompassing understandings. (p.264)

This perspective can be illustrated through the experience of one neurology student. She had used repeated concept maps summarizing each of the articles she read to see patterns of interconnections, and coming to appreciate how each researcher's interpretation was coloured by their individual perspective. She therefore consciously avoided firming up her understanding until seeing a complete picture.

The point is that reading any paper (or even a lecture), you have to recognise the views of the author. ... Each time you read a different article, you get a completely different picture of the topic. ... So, what you have to do is to try to imagine this new paper from another perspective; one you have already read. ... It takes time for a pattern to emerge – and you have to find it gradually – for yourself, ... getting to see why this question is important, while another one is not, or that this theory is more likely than another. Then you get a feeling for the author of each paper and for your lecturers too: a sense of where they are coming from and why such and such is important for them, ... getting to know the people that explain ideas or data. ... Then, in the end, I come to realize how everything is really related and I'm able to connect everything together - but this cannot happen until much later and when it comes, it is not as if I were looking for it - it just happens. (Hay, 2010, pp. 275-276)

Like this student, many other students regularly mentioned understanding as involving the creation of a personally satisfying pattern or structure that integrates important aspects of a topic.

I can see [the topic] virtually as a picture, and I can review it, and bring in more facts about each part. Looking at a particular part of the diagram sort of triggers off other thoughts. I find schematics, in flow diagrams and the like, very useful because a schematic acts a bit like a syllabus; it tells you what you should know, without actually telling you what it is. I think the facts are stored separately, and the schematic is like an index, I suppose. (Chemist)

Sometimes I can visualise parts of it. I can think about, perhaps, where certain things were... It must be that, in my mind, I'm just going back to the same structure that I had to begin with... (When I think back now) the general points are there, and the actual details all come flooding back, as it were. The general arguments that I included tend to be remembered. I would probably remember certain points, and then they may lead off to other points, and then they might start bringing things out. (Social historian). (Entwistle & Entwistle, 1997, p. 152)

Students often talked about this form of visualisation and how it helped them in testing out their understandings and using them later in exams. This led to the idea of *knowledge objects* (Entwistle & Marton, 1994) as 'quasi-visual' entities ("almost like seeing") created as students sought to bring together their ideas into a coherent whole that they would

subsequently be able to recall easily, and interrogate, in the exams. They are 'runnable' mental representations that can be used as a mnemonic for an exam, but do not represent understanding itself. Understanding still lies hidden, but is on the fringe of awareness, as a zoology student explained.

I just clear my mind and something comes. It's visual in some ways but it's also just there. I know it's there and I can either use it visually or else it will just appear on the page automatically, and then I can zoom in on examples. When I'm in an exam situation this visual memory is not so obvious because it's much faster, it's only in this [interview] situation where I can actually perceive it as a visual memory. In the exam, it may be that the visual memory is bypassed. I haven't time to look at it and it just comes out. I feel I'm searching a visual memory, or else a visual display of memory, where you have a 'central' memory which can either be expressed visually, mechanically or aurally, but in extreme stress situations comes straight out.
(Edited extract from the original transcript)

From the whole set of interviews, it seems that knowledge objects have two aspects: one is the structure that has helped the students to create a coherent picture of a topic with 'nodes' that pull in detailed information as required, while the other is the memory of the logical links created to provide a convincing explanation of the topic in the process of revision. Students described how their visual mnemonic provided them with a logical ordering of the topic, one that could be readily adapted to the needs of the question set, due to the thorough understanding that underpinned it. So, the knowledge object was also used to guide them through the writing of an essay or the solving of a problem.

It's almost as though it says, "Okay, we're doing Optimal Foraging, we're doing it in this order, get into line now!". Well, you start with evolution and you know where you're going from evolution, so you get there, and then suddenly you know where you're going next, and then you might have a choice to go in that direction or that direction, and you follow it through various options it's offering. Hopefully, at that point you'll be able to make the right choice, and so it could be that this goes to this, goes to this. When you've explained it to the level you've got to, it says "Okay, you can go on to talk about further criticisms in the time you've got left".
(Zoologist) (Entwistle & Entwistle, 1997, p.152-153)

From other extracts, it appears that a knowledge object is providing a generic logical pathway for students to follow, without necessarily constraining it (Entwistle, 2010). It appears that the process of writing, guided by the knowledge object but animated by the underlying understanding, may be extending that understanding recursively, with the new understanding emerging from the old one. Academic understandings and exam answers also

reflect the interplay between a student's and a tutor's thinking, as envisaged in Pask's (1976) conversation theory.

I try to take a critical stance on the material: the germ of it can be found in tutor's thinking, which is 'feeding' mine. I have a direction - her perspective – and this gets me into more thinking. I initially try to understand the issue, by putting myself in the tutor's shoes, how she appeared to personally think on an issue, and the issues that are raised again and again, indicating her convictions. So, you start with the tutor's perspective; you bring in your own previous knowledge and experiences that gets you to a different end from where you started. (Psychologist) (*Karagiannopoulou & Entwistle, under review*)

Although the form and level of understanding reached may vary markedly both over time and across courses and topics, some students show a relatively stable *disposition to understand* for themselves (Entwistle & McCune, 2009), which is part of the student's identity as a learner, and involves an emotional commitment to learning deeply.

I had to go through all the stages of working through the topic and showing that I had understood it: I couldn't gloss over the surface. I have to explain it in that way - you can't cut it up and avoid bits: half an understanding doesn't make sense! It's essential to demonstrate your understanding of the whole, and its implications and limitations and you also need to demonstrate a critical approach to any evidence. Among many of my friends, it's more underlying than that; it's not even the will to succeed, it's almost an obsession. (*Entwistle & McCune, 2009, pp. 43-44*)

What is academic understanding?

We started by looking at some theoretical ideas on the nature of academic understanding, suggesting three main perspectives. Understanding can be seen as mental representations within cognitive structure, as the learning processes involved in reaching it, or as the emergent property of mental operations within a neural net. Theorists inevitably point out the strength of their own conceptualisation, and yet each of them describes a recognisable facet of understanding. It might, therefore, be better to look for a broader perspective that indicates how they fit together.

Although there are considerable differences in the specific processes involved in developing and achieving an academic understanding, there is a discernible pattern among the students' experiences that involves a number of successive actions: the intention to understand for oneself; identifying and collecting relevant information and ideas; discovering their meanings and implications; noting the most salient elements and considering the relationships between them; seeing the overall picture and how the parts relate to the whole;

and deciding one's own position in relation to the evidence collected. And within that process, and in rather different ways, an event called 'understanding' takes place.

It may come without conscious effort after considering many aspects, but in other situations it may take much time and effort, involving putting ideas on paper and perhaps making diagrams or creating concept maps. But 'academic understanding' itself lies in the single event, when the connections are established to one's own satisfaction and the overall meaning is recognized. And that brings with it a complex of positive feelings, sometimes strong, even somatic 'gut feelings', but often just a warm feeling of satisfaction and self-confidence. Those feelings are important as they provide the impetus for attempts to repeat them, and so encourage the development of the skills and the learning processes that lead towards further experiences of deep, academic understanding. That is the strongest indication that helping students to acquire a disposition to understand for themselves is important at university level.

The picture of academic understanding can be made clearer by using composites of the most revealing comments within the extracts used earlier. These provide individual insights into the fleeting and very personal mental activities that lead up to an understanding and how that understanding, and representations of it, are used in the crucial next step - of making that understanding known to other people.

I came to realise how everything is really related and I'm able to connect everything together - but it takes time for a pattern to emerge, you have to find it gradually, for yourself, and when it comes, it is not as if I were looking for it - it just happens. But if I don't understand, it's just everything floating about and you can't quite get everything into place - like jigsaw pieces, you know, suddenly they connect and you can see the whole picture.

I feel I'm searching a visual memory, or else a visual display of memory, where you have a 'central' memory which can either be expressed visually, mechanically or aurally but, in extreme stress situations, comes straight out. I can see it virtually as a picture, and I can review it, and bring in more facts about each part.

Sometimes I can visualise parts of it. I can think about where certain things were, and then the actual details all come flooding back - I just clear my mind and something comes. Then, it's almost as though it says, "We're doing it in this order, get into line now!", and so this goes to this, goes to this, until you've explained it to the level you've got to.

I had to go through all the stages of working through the topic and showing that I had understood it: I couldn't gloss over the surface. I have to explain it in that way - you can't cut it up and avoid bits: half an understanding doesn't make sense!

Understanding may well be an emergent property of our natural, self-organizing ability to make sense of the world around us, but we also need to recognize it in terms of personal experiences of the cognitive processes, visualization and individual pattern making that lead to the feelings that usually signify its achievement. In some of the comments there is also a

suggestion that students feel that the processes of remembering an understanding and learning the details are somehow separate. And it may be that what we remember best is the process by which we arrived at an understanding rather than a representation of the understanding itself, and that each time we provide an explanation of it, we are reconstructing it along remembered paths but with a specific purpose and audience in mind.

Although these considerations of the nature of academic understanding do not lead directly to implications for university education, they should give pause for thought. How can we help students to become more aware of how understanding is established in specific disciplines and of how they themselves can organise their own thinking and studying to grasp the essence of the subject more clearly? There are many specific insights within the students' experiences, and within the other research cited, that would allow university teachers in the different subject areas to decide how best to answer these questions.

Conclusion

As we, the authors, brought together the different ideas and evidence about academic understanding, we were increasingly conscious of its complexity, and yet also aware that we had deliberately restricted the compass of our exploration. Understanding becomes bound up with ideas about language, communication, and cultural differences (Francis, 2010), but those went beyond the bounds of this current review. Moreover, we have only looked at the experiences of students, while an exploration of the understandings of academics would also have been valuable (Prosser *et al.*, 2005).

In the end, what have we contributed to the conceptualization of the nature of academic understanding? Hume set a task for future scientists -

to know the different operations of the mind, to separate them from each other, to class them under their proper heads, and to correct all that seeming disorder, in which they lie involved.

That was what we attempted to do for the nature of academic understanding in drawing on the experiences of students, and perhaps we offered some clarification. But we are left with the uncomfortable feeling that Hume may have been right after all, and these "operations of the mind" and their implications remain "involved in obscurity". But perhaps help is at hand, in the commentaries that follow. We recognize all too well that the ideas we have highlighted within the students' experiences of understanding are open to other interpretations, and our understanding of 'the nature of academic understanding' has been, and will continue to be, recursive as we respond to new evidence and other perspectives.

Footnote from the lead author

John Nisbet and I had many discussions about the nature of understanding over the years, right up until the penultimate draft of this paper had been produced, but he did not live to see the finished version. He died, aged 89, on 5th October, 2012, and so this paper is now dedicated to the memory of an outstanding educational psychologist and university teacher, and a great friend.

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