Understanding evidence in scientific disciplines: a concept map of 'the thinking behind the doing' and its importance in curriculum development.

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Abstract

In scientific disciplines, students' understanding of research and the uncertainty of the resultant data and claims has been the focus of much recent work in different disciplines. Various potential Threshold Concepts (TCs: see for instance Meyer & Land 2003, 2006, 2006) have been proposed including 'measurement uncertainty' (Wilson et al 2010), the 'testable hypothesis' (Ross et al 2010), 'uncertainty in climate change' (Hall 2010), 'quantitative numeracy' (Frith & Lloyd 2013) and 'academic numeracy' (Quinnell et al 2013). All these different aspects are related, at their heart, to students' understanding of research where weight is given to data as evidence.

TC-inspired research has, in particular, emphasised the importance of teaching for understanding, 'disciplinary thinking' and making the implicit explicit. Expertise in a discipline includes understanding its research, yet this has been considered hard to articulate since research expertise has widely been considered to encompass tacit understanding (Polanyi 1966, Sternberg 1999, Kinchin & Cabot 2010). How can we frame a curriculum based on tacit knowledge?

Kinchin (2008) has analysed expert practice, especially clinical practice, and has distinguished "chains of practice that are manifest in teachers' actions from the underlying networks of understanding". Chains of practice can arguably be seen in some research methods courses, laboratory procedures, fieldwork protocols and study guides (Kinchin & Cabot 2010). But we know that students do not always develop a deep understanding of evidence if research is presented as practice (Roberts et al 2010, Kinchin et al 2010). So *what* is it that needs to be understood to form a 'network of understanding' about research? In addition to the all important disciplinary concepts, experts also understand evidence – the key over-arching concepts being validity and reliability, underpinned by more detailed and inter-related concepts – so that they can apply this understanding by 'looking forward' when solving research problems (in a variety of different ways, with different research designs appropriate to different subjects; e.g. in lab-based manipulations of variables, fieldwork, observations, RCTs) and when 'looking back', evaluating the quality of evidence in others' research (Gott & Duggan 2003).

Gott et al (2010) have articulated and validated this 'thinking behind the doing' (see for instance Gott et al 1999) which has now formed the curriculum for 20 years of teaching and research into undergraduates' understanding of evidence in Durham. For instance, we have found that an understanding of the ideas of evidence was a necessary condition for success in open-ended investigations (Glaesser et al 2009) and that being taught about evidence enabled students to better ask questions about others' research (Roberts & Gott 2010).

Recently a network of ideas important for understanding evidence has been developed as a concept map (Novak & Cañas 2007) which Kinchin et al (2010) have argued is a way of visualising expertise; in this case, a map of the concepts of evidence underpinning expertise as opposed to descriptions of practice.

This talk will consider the Evidence concept map's potential for informing curriculum developments in scientifically-based disciplines where research gives weight to data as evidence so that the 'thinking behind the doing' can be made explicit.

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