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THE QUALITATIVE ANALYSIS OF CONCEPT MAPS: SOME UNFORESEEN CONSEQENCES AND EMERGING OPPORTUNITIES

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Abstract. The qualitative analysis of concept maps produced by students and teachers from secondary and higher education consistently show the occurrence of three morphological types: spokes, chains and nets. The significance of these structures is discussed in terms of their implications for university teaching and for further learning, and supports a reconceptualisation of the notion of *expertise* as a dynamic transformation of knowledge structures. This may provide us with a *threshold concept* for the evolution of university pedagogy- exhibiting the key characteristics of being transformative, irreversible and integrative. Implications for such a reconceptualisation of expertise are discussed.

1 Introduction

Application of concept mapping presented in this paper presents some divergence with the philosophy that implicitly underpins much of the literature that has employed concept mapping. This philosophical tension is particularly evident in the field of science education, in which there exists an epistemological gap between the objectivist philosophy of science and the constructivist philosophy of concept mapping (Kinchin, 2001). Much of the literature on concept mapping is concerned with the migration of students' understanding towards an accepted (or expert) view, which is typically hierarchical in nature. However, I am concerned here not with the 'correctness' of response, but with documenting personal change, using concept mapping as an act of rehearsal. Whilst the 'study-skill' approach to concept mapping has created important benefits for student learning, the potential of concept mapping goes far beyond this. Concept mapping provides a trigger for the development of scholarly, student-engaged pedagogy (Kinchin, Lygo-Baker and Hay, 2008), based on the visualisation of the elements of expertise (Kinchin, Cabot and Hay, 2008). It is this greater potential that I wish to explore here in the practical development and implementation of a bespoke approach to teaching that can foreground the professional values of academic disciplines in higher education. I encourage the reader to look beyond the implementation of concept mapping merely as a tool to remedy the deficiencies of an outmoded content-delivery-based curriculum, towards an approach to teaching that grants university students 'epistemological access' to their chosen discipline (eg. Gamache, 2002; Wingate, 2006; 2007), and which puts academics firmly at the centre of curriculum development (Cousin, 2008).

Some divergence from traditional concept mapping studies is represented in moving towards qualitative description of maps rather than the quantification of characteristics. This echoes Novak and Gowin (1984: 97) who stated that 'scoring was in many respects irrelevant' when looking for qualitative changes in understanding, and is further supported by comments made by Caine and Caine (1994: 166), that 'it is impossible to communicate the scope and depth of a student's abilities by means of a numerical grade'. It is also important to acknowledge the significance of 'invalid links' within a map. Bloom (1990: 560) comments that, 'the richness of meaning that accompanies many misconceptions is a significant part of the way we as human beings understand our world. To deny that richness of meaning is dangerous'. To overcome the issues surrounding scoring protocols, a qualitative typology of concept maps was derived from observations of several thousand maps (Kinchin, Hay and Adams, 2000).

2 Qualitative analysis

Even though it is *only* hierarchical networks that are used as exemplars when training research participants to construct concept maps, the spoke and chain-type structures often feature more commonly in the maps that are produced. The three maps shown in figure one all include the same content, but the variation in structural arrangement confers differing properties (Kinchin, Hay and Adams, 2000). These properties have implications for teaching and learning.

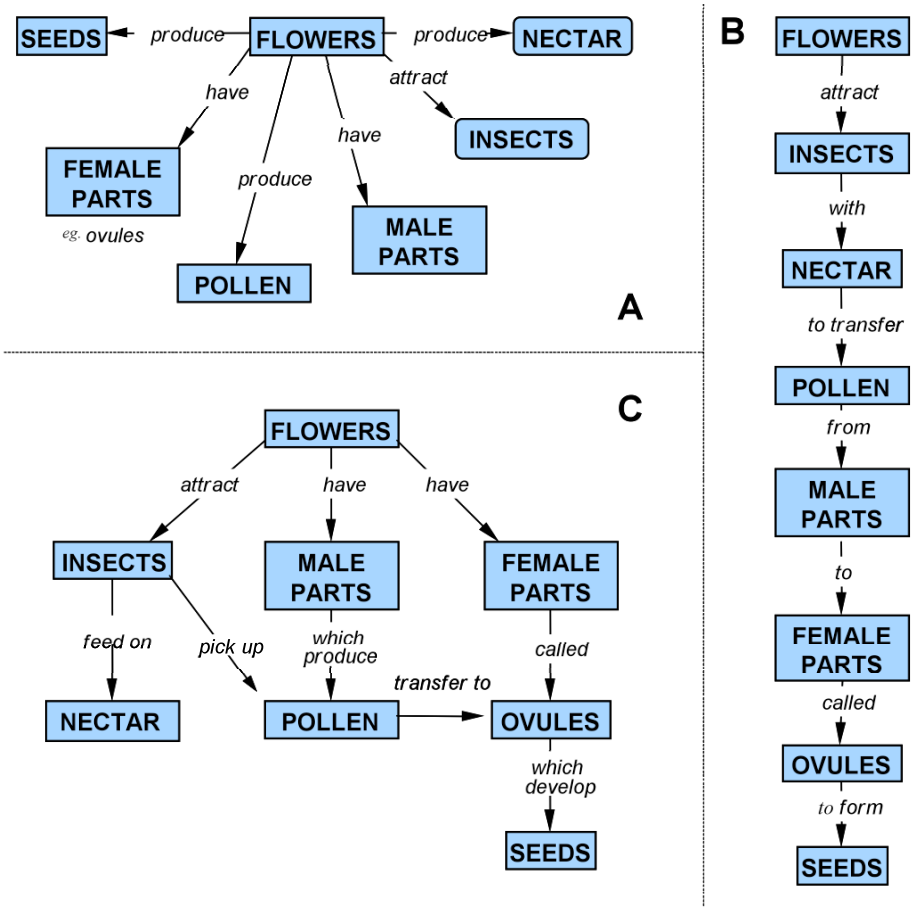

Figure 1. Morphological variation in concept maps. A = Spoke, B = Chain, C = Network. (After Kinchin, Hay and Adams, 2000)

The application of concept mapping to the qualitative description of knowledge structures has allowed the visualisation of the process of teaching and learning in novel ways that emphasize the organization of understanding. The revealed transformation of knowledge structures within the teaching and learning process has resulted in the emergence of a description of expertise that provides functional links between expert knowledge and practice (Kinchin, Cabot and Hay, 2008). The usual reference to these links as 'tacit' or 'intuitive' has previously helped to avoid the issue of how to develop a pedagogy that helps students to develop appropriate links between theory and practice and a trajectory towards expertise. A reconceptualisation of expertise in this way allows a re-appraisal of university pedagogy that addresses many of the inadequacies of current teaching programmes and helps us to 'reach the point where expertise can not only be verbalised, but passed on from teacher to pupil' (Rolfe, 1997: 1074). To appreciate the problems of higher education, I have reduced the evolution of university teaching to three broad steps:

3 Evolution of university teaching in three broad steps

Considering the development of teaching in three broad evolutionary steps is a simplification of reality. However, through simplification, the key characteristics can be highlighted sufficiently to resonate with the experiences of university teachers.

The 'content-transmission' model is based around the transmission of information rather than the transmission of understanding. One problem is deciding which content should be transmitted: much of the information that will be given to students in their first years of study will be obsolete before they qualify (particularly when engaged in long courses such as medicine or dentistry). Predicting which content will have a longer shelf-life and continue to be of use to the students is a difficult problem. When assessing students' acquisition of content within this model, it is impossible to separate what has been gained from formal and

informal sources. In other words, how can you tell how effective the teaching has been, unless students are routinely tested before instruction to determine the level of their prior knowledge? The notion of content transmission also implies that there is a fixed 'end-point' to learning (ie. once the prescribed content has been transmitted). Such a view invites strategic/rote learning to achieve the end point as quickly and effortlessly as possible, and works against a regime of meaningful/personal learning.

The 'responding-to-student-learning-needs' model has gained currency with the recognition of the diverse and changing needs of large number of students in an expanding higher education sector. This is perceived as setting impossible goals that represents a 'step too far' for many university teachers (Cousin, 2008: 268). Whilst Simon (1999: 42) is explicit in his criticism of this model in stating that, '*starting from the standpoint of individual differences is to start from the wrong position. To develop effective pedagogy means starting from the opposite standpoint*'. Even if students' learning styles could be reliably determined, it is not clear how teaching should be targeted at matching or complementing these styles. Attempts to classify student learning using learning styles inventories has been shown to reduce the acknowledged range of student learning styles to a small number that in turn, have been used to label students and promote commonality rather than diversity (Ritter, 2007).

The 'expertise-based' model requires teachers to have the courage to share their knowledge, and the gaps in their knowledge. Patel, Arocha and Kaufman (1999: 89) describe how 'An effective clinical teacher needs to be able to articulate knowledge that would normally be tacit for a practitioner not normally engaged in instruction'. The knowledge structures approach, facilitated by concept mapping tools, provides a mechanism to go beyond making learning visible, towards making it tangible (ie., not only can it been seen, but it can also be manipulated to support development).

4 Characteristics of experts

A reconceptualisation of expertise as a dynamic transformation of knowledge structures, relating competence and comprehension can be represented by chains of practice and networks of understanding revealed by concept mapping. This view of expertise has provided us with a threshold concept (*sensu* Meyer and Land, 2003; 2005; 2006) for the evolution of university pedagogy, whilst moving away from the problematic binary of student/teacher centredness. Our model also rejects reductionist notions of expertise fostered by an audit culture, preferring an integration of the elements of professional practice. This model facilitates the academic reclamation of pedagogy, placing subject specialists at the centre of pedagogic developments and provides a mechanism to initiate and monitor a more transactional curriculum (*sensu* Cousin, 2008). Amirault and Branson (2006) provide an overview of expertise research related to education. The principle characteristics of experts in any domain is that they posses an extensive and highly integrated body of knowledge related to their discipline (Patel, Arocha and Kaufman, 1999). This is coupled with the ability to perceive patterns in large amounts of information and to process their responses quickly and efficiently. Uncovering the knowledge bases held by experts to gain insight of the nature of the structures that might be indicative of expert understanding (Bradley, Paul and Seeman, 2006), has led to the use of concept mapping as an exploratory tool (Hoffman and Lintern, 2006).

5 Chains and networks

The ability to visualize reasoning processes is considered to represent one of the first steps in the formation of the cognitive skills that are necessary for professional practice (eg. Hill and Talluto, 2006). Visualization of knowledge structures through concept mapping has enabled us to separate the *chains of practice* that are manifest in teachers' actions from the underlying *networks of understanding* (see figure 2). Chains are indicative of procedural sequences that characterize observable practice and have been described as indicators of 'goal-orientation' (Hay and Kinchin, 2006). This seems entirely appropriate in some settings, such as clinical practice, where the goal of clinical competence is the effective treatment of patients. However, if there are no links with an underlying understanding, the chain may be seen as blindly following a recipe.

Networks indicate understanding that is integrated and wholistic. So, for example, knowing there are several alternative treatments with varying consequences is not the same as being able to select the most appropriate one within a clinical context. If this was the case, academic study would not need to be backed by clinical training.

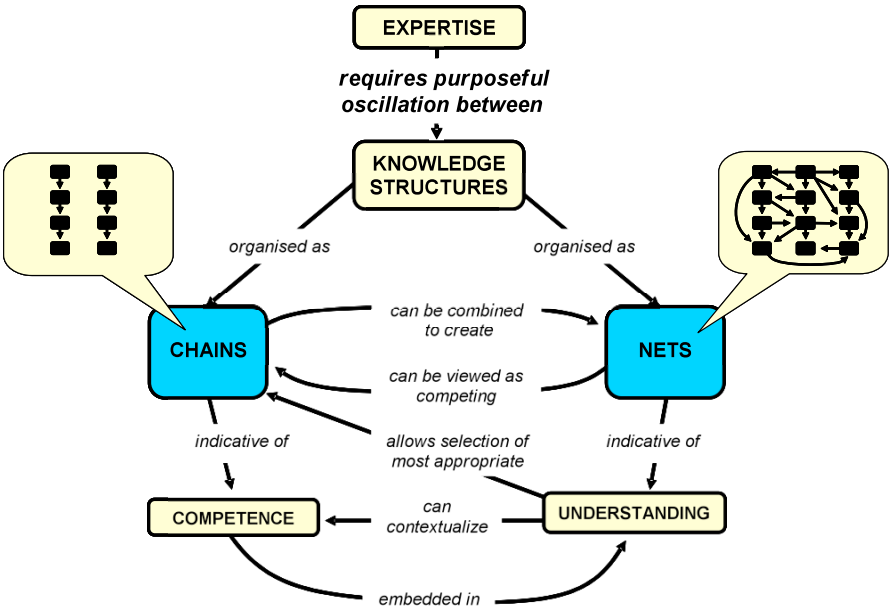

Figure 2. Relating chains of practice and networks of understanding: the locus of expertise. (modified from Kinchin and Hay, 2007)

6 Application to teaching

In the clinical teaching arena, Patel, Arocha and Kaufman (1999: 89) have explained that an effective clinical teacher 'needs to be able to articulate knowledge that would normally be tacit for a practitioner not engaged in instruction'. It is precisely the articulation of this tacit knowledge that is facilitated by the model and by the concept mapping tool, providing students with the key information they need to develop their own emergent expertise.

The tacit knowledge that needs to be placed in the public arena for teaching is found connecting the chains of practice that are manifest in the teacher's actions and the underlying network of understanding that is usually held privately (Kinchin, Cabot and Hay, 2008). The student needs to gain experience in converting between complementary chains and networks. Such structural transformations can be modelled for the student, once the teacher has recognized them. Engagement in concept mapping activities allows the teacher to recognize the existence of the structures and allows him/her to make them public to the students within the course of teaching. The concept mapping tool also slows down the process (that is usually automated) to facilitate its examination. So, for example, the typical structure of a practical procedure would be a chain of practice that would be communicated to the student. The student's competence would be assessed through his/her ability to reproduce that chain under varying conditions and with various patients. The student's developing expertise, however, must be assessed through his/her ability to relate the chain of practice to the underlying network of understanding, and explaining how the elements are linked, and how and why the chain of practice should be modified in response to changes of context. This represents a shift in the emphasis of the transactions between teachers and students from fixed end-points to linking activities.

7 Intuition and tacit knowledge

A difficulty in developing a pedagogy of expertise is the central position given to intuition and tacit knowledge in some of the models of expertise (particularly within clinical education e.g. Benner, 1984; Dreyfus and Dreyfus, 1986). If intuition and tacit knowledge cannot be explained or modeled for students, they would not make a good basis for university pedagogy. However, we do not see tacit knowledge as a barrier to developing a pedagogy of expertise so long as it is viewed as knowledge that has *not yet* been revealed rather than knowledge that *cannot be* revealed (Eraut, 2000). We see intuition based on tacit knowledge as simply the poorly articulated links between chains of practice and underlying networks of understanding, and agree with Welsh and Lyons (2000) that it would not be possible to use intuition unless it was linked to formal knowledge.

Yielder, (2004) has shown how some expert knowledge is explicit, and by supporting reflection, theoretical and procedural knowledge can be made more conscious. If colleagues have been unable to verbalize their actions in the past, it may simply be that they have lacked the appropriate tools to uncover what it is that they were doing, and/or the vocabulary or self-awareness to articulate it (Jarvis, 1996). Hoffman and Lintern (2006) argue that there is no indication that tacit knowledge 'lies beyond the reach of science in some unscientific netherworld of intuitions and unobservables', and that appropriate tools (such as concept mapping) can support colleagues in identifying and clearly describing their practice with the aim of improving teaching effectiveness (Mcleod *et al*., 2004). Rolfe (1996) comments that rather than considering intuition as a magical process of knowing, it should be considered as the unconscious workings of the prepared mind. By revealing these workings through the application of concept mapping, the tacit can be made explicit (Hoffman and Lintern, 2006).

8 A way forward

Unlike other recent developments in modelling expertise (eg. Yielder, 2004; Dall'Alba and Sandberg, 2006), the model proposed here addresses a number of the issues that currently inhibit the development of university teaching beyond the cycles of non-learning that have been highlighted by Kinchin, Lygo-Baker and Hay (2008), and challenges the 'safe systems' that dominate university teaching (Canning, 2007). It addresses the theory-practice gap. The content-focused teaching model can result in the separation of that which is learnt in theory from that which is learnt in a practical context (including clinical environments, laboratory practicals and fieldwork exercises). The expertise-based model requires that teaching should actively focus on the links between theory and practice so that, by default, the problem of a gap is overcome.

It provides the *epistemological access*, called for by Wingate (2007). The objectivist epistemology that typifies the transmission mode of teaching has given way in the educational literature to a more constructivist epistemology – paralleling the shift from a focus on teaching content to a focus on students' learning. This can cause lecturers difficulties where the epistemology of their discipline is felt to be in conflict with the epistemology of educational development.

The evolution of university pedagogy will only be successful if all involved are committed to the enhancement of student learning, and the discussion of pedagogy is seen as part of the general discourse of higher education rather than the preserve of specialists in teaching and learning (Green and Lee, 1995). A tentative, partial implementation of an expertise-based pedagogy will fail. For success, the model needs to be accompanied by development of an appropriate assessment regime and an explicit acknowledgement of the expectations that are placed on teachers and students. Teachers need to consider the application of the model to their own discipline and be granted time and resources to ensure that cycles of non-learning (*sensu* Kinchin, Lygo-Baker and Hay, 2008) can be avoided.

9 Implications for teaching and assessment

Whilst the novice teacher may cover the same content as an expert colleague, content-centred transformations (usually linear in nature, corresponding to 'chain-type' concept maps – as described by Kinchin, Hay and Adams (2000) do not promote subject expertise. The 'linear teaching approach' keeps the student as distant observers of the material, rather than as a participant engaged in its construction (Northedge, 2003). This provides a concrete example of the phenomenon described by Lea (2005: 193) when she states that, '*most university teaching and learning practices are not about inclusion but tend to position undergraduate students as permanent novices*'. The chain-type framework that can be promoted by novice teachers is difficult to interact with and so is only helpful in teaching if the aim is to support rote learning and memorisation of information – indicating a 'transmission' view of teaching. The spoke-type framework provides a more fertile base upon which to add concepts and develop ideas for the construction of personal understanding, and has been described as indicative of being 'learning-ready' by Hay and Kinchin (2006). The problem of moving from linear (often text-based) structures to hierarchical (psychological) structures and back again has been described by Novak and Symington (1982) as a fundamental educational problem.

We need to be clear that adoption of the expertise-based pedagogy described here does not require all teaching to change. Rather than dictating to academics *how* they should act, part of the reason for visualising the hidden processes of expertise is to make explicit how they already do act. The strength of the pedagogy of

expertise therefore lies not in its prescriptive ability, but rather in its descriptive ability. There remains a role for many of the practices that are held dearly within university teaching, so long as they are practiced with understanding. For example, there is a role for the linear presentation of knowledge (exemplified by the traditional lecture), as long as students are given suitable guidance/opportunity to relate the linear sequence to other structures, either through active engagement during the lecture (Jones, 2007) or through active engagement with complementary activities/resources.

For young university academics, the consideration of teaching as a problematic and complex activity is one of the most *troublesome* issues to manage Savin-Baden (2006). Academics often fail to recognize teaching as a problematic activity and resort to teaching as telling and learning as receiving (as described by Van Leuven, 1997) as the default setting of university teaching.

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