CHAPTER 5

THE EXPERT STUDENT

The Need to Manipulate Knowledge

INTRODUCTION

The concept of the 'expert student' has been considered for some time (e.g. Sternberg, 1998, 2003). Here I am considering the expert student in the context of knowledge creation and the ways in which learning approaches can utilize disciplinary knowledge structures in order to develop authentic understanding and practice. As such, the expert student has been defined as '*one who recognises the existence and complementary purposes of different knowledge structures, and seeks to integrate them in the application of practice*' (Kinchin, 2011: 187).

Concept mapping studies of expert practice have suggested a dual processing model of expertise in which the expert has to deal simultaneously with the linear structures inherent in practice/experience and the hierarchical structures typical of conceptual understanding (Kinchin & Cabot, 2010). While the expert practitioner can undertake these knowledge transformations in an automated and opaque manner, the expert teacher has to offer more transparency and reveal these transformations to his/her students. This has been summarised by Tsui (2009) as the complementary capabilities of 'theorizing practical knowledge' and 'practicalizing theoretical knowledge' – skills that needs to be modelled for students.

CONSIDERING EXPERTISE

The model in Figure 28 was derived from the qualitative examination of several thousand concept maps produced by students and their teachers over a 10 year period (Kinchin, 2000; Kinchin, DeLeij, & Hay, 2005; Kinchin & Hay, 2007; Kinchin, Cabot, & Hay, 2008). These maps were elicited from students and teachers from a wide range of arts and science disciplines. The studies have indicated a great diversity in patterns of learning such that a teacher could not hope to track the learning pathways of all the students in a cohort. But the maps have indicated the importance of knowledge transformations and knowledge structures that are particularly helpful in relating theory and practice (Kinchin, Baysan, & Cabot, 2008).

The vertical dimension of Figure 28 (reading down each side of the figure from top to bottom) explains the characteristics and roles of each of the knowledge structures – chains and nets. Many students embark upon their undergraduate studies with firmly established chains of understanding that have developed during their secondary schooling.

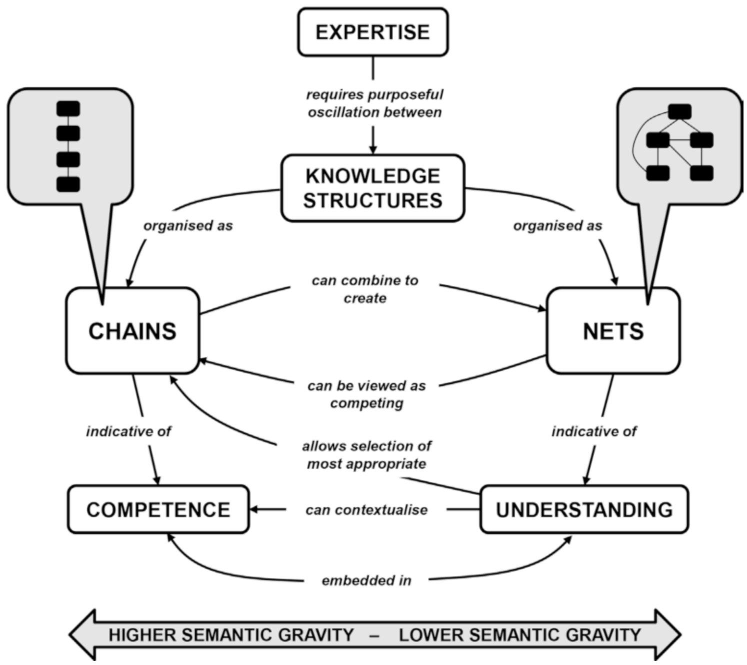

Figure 28. A dual-processing knowledge structures perspective on the nature of expertise (After Kinchin & Cabot, 2010)

The chains result from students' repeated exposure to linear teaching sequences in which materials are presented to facilitate rote learning. These chains are often incomplete or inappropriate for their new context – typically representing a single route through a sequence of ideas. They are resistant to development (Hay & Kinchin, 2006) and so students are faced with the dilemma of either trying to abandon their existing beliefs or rote-learning the new material as an adjunct to their existing prior knowledge (Hay, Wells, & Kinchin, 2008). The chain of appropriate understanding is indicative of strategically successful learners (students and lecturers) as they represent the most economical way of storing key points of information – indicated by the dominance of such structures within student study guides. Such goal-orientation enables these learners to select the essential information from that which is available whilst selectively ignoring the rest. This may be seen by some as an efficient way of studying (avoiding blind alleys and tangents to thinking) whilst others could interpret this as a blinkered view of higher education that does not encourage alternative points of view. There is certainly a tension created within the university environment by attitudes towards this kind of strategic learning that may reflect disciplinary differences. For example, in the clinical environment the development of chains of clinical reasoning is seen as one of the key aims, so that students can be seen to perform sequences of procedures with a high degree of competence (Talbot, 2004).

The demonstration of highly developed and integrated networks of understanding may be seen as the hallmark of the expert (Bradley et al., 2006), for whom the demonstration of expertise is achieved by the accommodation of competing chains of understanding and the selection of appropriate chains to suit particular contexts. The chains are described as 'competing' as a particular chain may be seen to be more appropriate in a given context that an alternative (or competing) chain. However, the competitive value of a chain may change as the context develops so that an alternative chain may be selected at a later date. Net structures need to be explicitly connected to chains of practice if they are to have any practical application. In some disciplines, this may be seen as linking 'professional' and 'academic' learning, with professional learning concentrating on the development of linearly arranged practical procedures and practices and the academic learning focussing on the integration of understanding. This linking of theory and practice is often a source of difficulty in many vocational university courses, such as dentistry or engineering. The dual processing of the two formats (nets and chains) supports the contention that '*expertise lies in the availability of multiple representations of knowledge*' (Norman, 2005: 418). This also resonates with the work by Vance, Zell, and Groves (2008: 232) who consider the issue from a learning styles perspective and concluded that '*successful individual innovative capability actually would tend to reflect both nonlinear and linear dimensions in a composite thinking style*'.

A horizontal reading across the model suggests a progression in the development of knowledge structures from chains to nets, i.e., that students may initially memorise sequences of information that are later integrated into a more holistic understanding of the subject. Such a directional development has been observed (Kinchin, Hay, & Adams, 2000) though the mechanisms of change are complex. The implication that the development of net structures among students may be the goal of higher education is one that may be contested, particularly where chains of practice seemingly have more immediate practical application than networks of understanding. In the clinical context, the chains and networks need to develop in parallel. As an individual develops expertise, the networks of understanding will develop sophistication whilst the choice of embedded chains of practice will also grow. The smoothness of transition between the two will increase with increasing expertise. Unlike other models of expertise (e.g. Yielder, 2004; Dall'Alba & Sandberg, 2006), the model proposed by Kinchin and Cabot (2010) addresses a number of the issues that currently inhibit the development of university teaching beyond the self-limiting cycles of non-learning that have been discussed by Kinchin, Lygo-Baker and Hay (2008):

1. It addresses the theory-practice gap that features in so much of the literature, especially in the applied and clinical sciences. The explicit focus on the links between the chains of practice and networks of understanding (practice and theory) that allow the model to function effectively overcomes this problem.
2. It facilitates epistemological access where the epistemology of a discipline is seen to be in conflict with the epistemology of educational development. Taylor (1993) describes in accessible terms how she came to grips with her own epistemological conflict. Such a personal challenge is seldom acknowledged in public, and the sanitized nature of academic writing never suggests that such personal issues are widespread among the academic community. Taylor's personal account may provide an exemplar against which colleagues could compare their own situations.
3. It places the responsibility for learning on the shoulders of students. The teacher has to be able to demonstrate the manipulation of knowledge that is appropriate for the discipline (e.g. from chains to nets and back again) in an explicit manner that is visible to students and then provide the appropriate learning environment where students can try this for themselves.
4. It places teacher development within the disciplines and so the traditional 'battlegrounds' between academics and academic developers (e.g. student vs. teacher-centredness) become obsolete, with focus now on a common interest – the development of expertise-centredness. This shift allows the discussion of pedagogy to become part of the general discourse of higher education rather than the preserve of specialists in teaching and learning (e.g. Green & Lee, 1995).

EDUCATION FOR EXPERTISE DEVELOPMENT

From their analysis of the literature, Elvira et al. (2016) have developed ten interrelated instructional principles to promote expertise development. In the context of the knowledge structures approach, these are:

1. *Support students in their epistemological understanding*. The epistemological underpinnings of the knowledge structures approach is emphasised in Chapter 2 (see Figure 5). The complexity and uncertainty in knowledge should not be kept away from students in order for them to have the opportunity to develop their skills in processing information, reason more effectively and develop better problem solving skills. Dolan and Collins (2015) talk about the value of open-ended, messy or 'wicked' problems which demand more than simple factual answers – outcomes that may even have the power to shock and surprize (Young & Muller, 2013).
2. *Provide students with opportunities to differentiate between and among concepts.* Elvira et al. (2016) consider the importance of providing students with repeated encounters with ideas in a range of contexts. This fits with the comments made by Maton (2014a: 106) who considers the widespread problems created by

the segmentalism of learning that results in meaning being so tied to context that it is only meaningful in the context in which it was learned. This he refers to as a 'spectre that is haunting education'. Kaipainen et al. (2008: 477) conclude that a single perspective should be regarded as a transient and partial view of a complex environment, and that a 'more profound comprehension emerges in the course of an iterative process of exploring the data from alternative perspectives'. The need for a cognitive system that 'binds together subsequent perceptions', may be fulfilled by the application of threshold concepts, whose function is to integrate concepts (Meyer & Land, 2006).

3. *Enable students to experience complexity and ambiguity*. The problems that are presented to students need to be authentic and not over-sanitized versions of reality. Otherwise we end up with problems like the ones I have encountered when students in a dissection class have informed me that '*their rat is wrong*', because its interior organs do not look like the drawings in the textbook. The complexity and ambiguity inherent in university level knowledge can be emphasised through the application of concept mapping. However, for the tool to have a positive contribution, it is vital to achieve alignment between the instructional goals and assessment regime with the concept mapping exercise (Bentley et al., 2011).
4. *Enable students to understand how particular concepts are connected*. This is the essence of concept mapping and the knowledge structures approach. The connections between concepts are possibly more important (and certainly more demanding to write down) than the concepts themselves. As stated by Goldsmith et al. (1991: 88), '*To be knowledgeable in some area is to understand the interrelationships among important concepts in that domain*'.
5. *Target for relevance*. The so-called 'theory-practice' gap is considered in some disciplines to be the most important challenge to the concept of research-based practice (e.g. Scully, 2011).
6. *Share inexpressible knowledge*. Elvira et al. (2016: 9) state that '*converting procedural knowledge into conceptual knowledge means finding a way to express the inexpressible*'. The issue of the inexpressible has been explored by Kinchin, Cabot and Hay (2008) who considered tacit knowledge to be found in the spaces between complementary knowledge structures. That experienced teachers cannot always articulate rational explanations for their practice resonates with Polanyi's view of tacit knowledge as a description of 'knowing more than we can tell' (Polanyi, 1967: 4). But the 'black box' of tacit knowledge and intuition does little to support the student or the teacher in the development of academic expertise. If colleagues are unable to verbalize their actions, it may simply be that they lack the appropriate tools to uncover what it is that they are doing, and/or the vocabulary to articulate it. Hoffman and Lintern (2006: 216) 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 tools such as concept mapping can support colleagues

in identifying and describing their practice with unprecedented clarity. That knowledge may be tacit is not in doubt. Where I depart from many accepted views is that not all such knowledge need remain tacit and undescribed. Transparency, mediated by concept mapping, may help students and teachers appreciate the other's perspective and avoid the problem described by Perkins (2006: 40):

> Learners' tacit presumptions can miss the target by miles, and teachers' more seasoned tacit presumptions can operate like conceptual submarines that learners never manage to detect or track.

7. *Pay explicit attention to prior knowledge*. Central to the implementation of an expertise-based approach to teaching is the conceptualisation of learning as change: a process of development from prior knowledge to new understanding. Ausubel (2000), whose theory of learning lay the groundwork for the development of concept mapping, has commented that what students know already is the most important thing to identify before teaching starts as this represents the cognitive raw material that students have at their disposal to support further learning. However, teachers in higher education comment that in practical terms, it can be very difficult to access students' prior knowledge for the purpose of conducting a meaningful dialogue. Concept mapping provides the practical tool to make prior knowledge visible (Hay, Kinchin, & Lygo-Baker, 2008). Once in this form, students can share their understanding with their teacher, their peers or even reflect upon it themselves in a manner that was not previously practicable. My experience undergraduate students has been that they will engage with each other enthusiastically to discuss the merits of different concept map structures in ways that I have not observed with other classroom strategies. Students embarking upon an undergraduate course will always have some prior knowledge of the field. This prior knowledge may be well-constructed and appropriate to the context (in which case it will help the students' future learning), or it may be fragmentary and full of errors and misconceptions and lack the semantic range expected at undergraduate level (Kelly-Laubscher & Luckett, 2016), in which case it will create an impediment to future learning. Making prior knowledge visible so that it is available for scrutiny will help the student to articulate the difficulties s/he may be having and provides a common language for students to share understandings with each other and with their teachers. It makes misconceptions easier to diagnose and helps to focus the teacher's attention to where it will be most beneficial.
8. *Support students in strengthening their problem-solving strategies*. The development of concept maps that summarise knowledge tend to emphasise the process of constructing understanding. This is of great value to students who are engaged in problem-based learning where the recognising the process of coming to an answer is often as important as achieving the answer. Problem

solving is seen as a way forward to develop meaningful learning, particularly in ill-structured domains where there is rarely a single answer to be extracted from the problem. In such cases, the mapping of the process may well be of benefit to the learner (e.g. Wu et al., 2013).

9. *Evoke reflection.* The application of concept mapping to reveal knowledge structures offers a tool to support reflection. It allows the visualisation of novice and expert thought processes so that students are able to see the distance they have to travel to acquire a level of expertise in the subject. By laying bare the thought process as a concept map, the student can offer his/her thought processes for critique which makes it difficult for the student to offer an outcome that simply mimics expertise.
10. *Facilitate metacognition.* Elvira et al. (2016) consider students not only need to develop metacognitive knowledge, but also need to be given tools to plan, monitor and evaluate their own work. The visual prompts provided by concept maps are likely to be more dynamic and integrated that the use of checklists in this regard. Salmon and Kelly (2012) have explored the application of concept mapping as a metacognitive tool for teachers to help them think critically about their teaching and suggest that teachers' metacognitive ability can be differentiated by the quality of the concept maps they produce.

SETTING EXPECTATIONS

The expectations that students bring with them to the classroom can be a major determining factor in how teaching will be received, and how innovation can succeed or fail. Díaz et al. (2008) describe how poor student performance often results from a mismatch between what teachers expect of their students and what those students imagine their task to be. If teachers expect students to act like sponges, passively absorbing information, then that is probably what they will do. But if students do not know what is expected of them, how will they behave as learners? Díaz et al. (2008) go on to explain, in the context of history, how most professors learned how to be disciplinary experts by 'osmosis', without explicit instruction on how to perform many of the operations necessary to produce disciplinary knowledge.

Without explicit reflection on what they do automatically, teachers fail to model for their students some of the most basic and essential steps in their work without realising that these activities are not natural for many of their students. In consequence, these activities remain invisible for the students, leaving students with the facts of the subject, but no idea how they were created. Identical scenarios are played out in other disciplines where the actions of experts can be so quick that students are unable to identify the steps that have been taken. Without an explicit role model in how to learn, students often revert to memorisation and rote learning. But this is not a way to develop expertise.

MOVING BETWEEN KNOWLEDGE STRUCTURES

Practice knowledge and theory knowledge may be separated and exhibit distinct knowledge structures. This is often exaggerated in university curricula where the 'practice' is often taught by 'practitioner-teachers' in the practice setting (clinics, surgeries, laboratories, courts, factories etc.), whilst the conceptual knowledge is often taught by 'teacher-researchers' at a different time and in a different place (through lectures, seminars, tutorials etc.). Typically the practice knowledge is quite linear in structure to emphasise efficiency and clarity of procedures, whereas the theory knowledge tends to be more of a networked structure in which multiple links and avenues can be designed to create uncertainty and creative thought. If the students are unaware of the differences between the two knowledge structures (in terms of design and purpose) they will find it difficult to relate the two – contributing to the 'theory-practice gap'. The teaching of language has not developed a prominent profile within the concept mapping literature, but comments made in the literature can be interpreted from a knowledge structures perspective. For example, McCormick (1994: 49) acknowledges the process view of reading as textual competence (taking information from the page), but then elaborates a wider socio-cultural view of text appreciation in which students '*must be given access to discourses that can allow them to explore the ways in which their own reading acts are embedded in complex social and historical relations*', to demonstrate cultural competence.

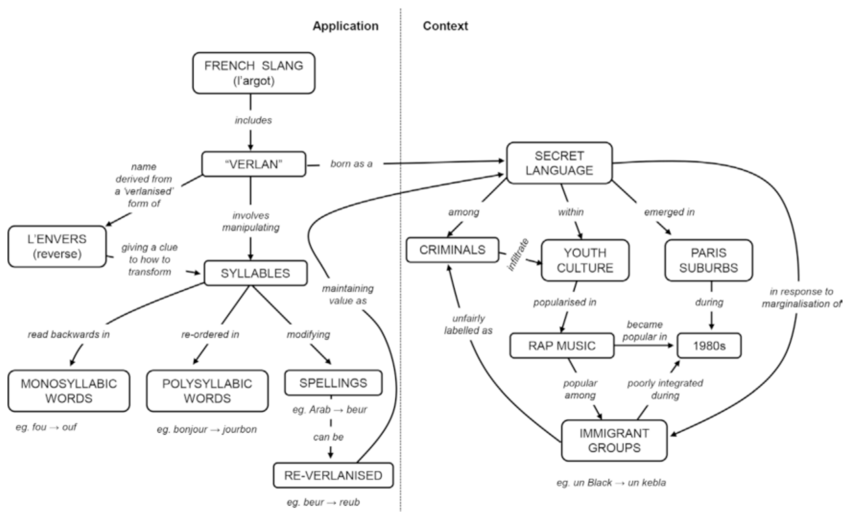

Figure 29. A student's knowledge structure of the application and social context of French slang (verlan) (After Kinchin, 2013)

Figure 29 is a student's knowledge structure of French slang (verlan) made to summarise a class on the subject. Here the application is seen as a protocol to be followed in order to ‘verlanise’ language, whilst the social context within which this practice has evolved is quite networked. Importantly, the two knowledge structures are linked. It is therefore possible for someone to learn to use the slang by simply adopting the procedures to verlanise words (changing the orders of syllables or altering the spelling to create ‘new’ words). The chain of practice here relates to textual competence (Nord, 1991), whilst the network of understanding relates to a wider appreciation of culture (Witte, 1996). However, for someone to use verlanised French without having any regard for its origins within the youth culture of Paris may give the appearance of being in-authentic or generating a parody that may be insulting to the social groups who developed it. Therefore adoption of the procedures without an appreciation of the underlying theory would simply be to mimic expertise in this domain.

Figure 29 is a ‘student map’, produced by someone who is still learning about verlan, but who was not yet an expert in its application. As such we can see that whilst the theory (network on the right) and practice (chain on the left) are quite well developed, the map still has room for refinement in order to make the chain of practice more efficient and maybe to generate a more robust link between the two structures. In contrast, the maps in Figure 30 were constructed by a disciplinary expert.

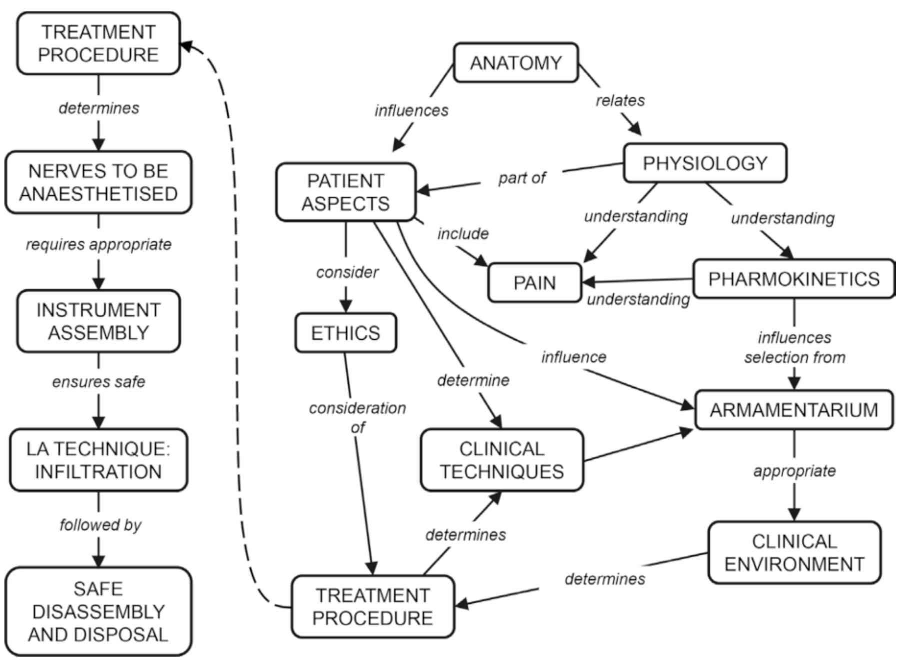

Figure 30. An expert’s knowledge structure of the application of local anaesthesia (LA) in dentistry (After Clarke, 2011)

Within this expert's knowledge structure the well-developed chain of practice and network of understanding are quite separate, linked by a single robust link that moves the 'treatment procedure' from theory into practice. The chain of practice is simple, with no deviations. Development of such an efficient chain is required in order to develop agreed clinical protocols that can be understood by a clinical team who may be holding different levels of theoretical understanding (e.g. between nurses and doctors or dentists). Competence frameworks (e.g. Talbot, 2004) therefore have a place in certain domains of education where the student is only concerned with developing the efficient chain of practice. However, such chains are only efficient within a largely predictable environment that presents the same problem over and over again. In such cases, routinized expertise may be seen as the goal. But where the environment is less predictable or changing in a certain direction, the routinized chain may not be fit for purpose. In such cases, the expert understanding of the theory is needed in order to provide the knowledge that allows the chain of practice to evolve. Individuals who are excluded from the underpinning theory will be denied access to the powerful knowledge of expertise (Wheelahan, 2007). This is when the expert is able to select or adapt to the most appropriate chain for an unusual instance by reference to the related theory. Whilst this is easy to appreciate in a clinical environment, it is also true of the map of verlan (Figure 29), where for the language to remain 'secret', it has to adapt as it is decoded by outsiders to the community. Expertise, therefore, requires the purposeful oscillation between the chain of practice and the network of understanding (Figure 28). The fluidity of this linkage makes the expert knowledge powerful.

DEVELOPING POWERFUL KNOWLEDGE

Recognition of the variety of knowledge in terms of structure and function allows students to develop understanding that has utility beyond the immediate goal of passing the exam. This more nuanced appreciation of knowledge goes beyond the simple deep-surface dichotomy that is described within many teacher development programmes (e.g. Kandlbinder & Peseta, 2009). It not only relates to 'acquisition-of-the-known', but also granting possible access to the 'yet-to-be-known' (*sensu* Bernstein, 2000), and 'new ways of thinking' (*sensu* Young, 2008), that '*frees those who have access to it and enables them to envisage alternative and new possibilities*' (Young & Muller, 2013: 245).

Traditional transmissive teaching approaches tend to emphasise the contents of the 'nodes' of information that are a feature of the visual representations used in this book. So, for example in Figure 30 the nodes (pain, physiology, clinical techniques etc.) represent the topics to be learned, and probably also the titles of the modules in which the content is packaged. Teaching to support the development of powerful knowledge also needs to emphasise the nature of the links between the nodes. This is where students can generate an appreciation of the explanatory power of their knowledge, as discussed in Chapter 2. Therefore to support the development of powerful knowledge and develop student expertise we need to:

> provide students with access to the relational connections within a field of study and between fields, and students need access to the disciplinary style of reasoning to move beyond a focus on isolated examples of content. Unless students have access to these relational systems of meaning they will not be able to drive the production of knowledge, or to determine the criteria they need to evaluate knowledge. (Wheelahan, 2010: 84)

Students will need guidance in the evaluation of knowledge as they will not have access to the whole disciplinary picture. This guidance is unlikely to emerge as a happy accident and so requires intentionality on the part of the teaching team who need to appreciate the ways in which different forms of knowledge are brought to the curriculum by their colleagues. For example, in the clinical scenario in Figure 30, the clinicians who teach the chain of practice may be separate from the scientists teaching the physiology. Mastery of one aspect of the subject is not enough. Students need to grasp the 'conceptual spine' that runs through a discipline. Teachers need to ensure that this is not 'scrambled' as a consequence of disciplinary fragmentation or modularisation of the programme (Muller, 2009). Clear conceptual links across a programme of study are not just desirable they are a necessary condition for students to construct powerful knowledge:

> 'powerful knowledge' comprises not one kind of knowledge but rather mastery of how different knowledges are brought together and changed through semantic waving and weaving. (Maton, 2014b: 181)

In view of the comments made by Maton, it seems obvious (but may still benefit from stating explicitly) that dependence upon a single theoretical perspective on educational research (e.g. sociological or psychological) or on a single disciplinary context (e.g. arts or sciences) or a single methodological perspective (e.g. quantitative or qualitative) is unlikely to generate a complete picture of learning in higher education. Maton's 'waving' and 'weaving' needs to encompass an acknowledgement of epistemological pluralism within the university (e.g. Miller et al., 2008) to help generate a more integrated understanding and avoid the creation of competing bodies of powerful disciplinary knowledge – which would then (paradoxically) not be powerful at all, except in maintaining territorial fiefdoms. I therefore, have to acknowledge here that the knowledge structures approach that is the focus of this book has to be seen as one perspective on the development of university teaching that will be complemented by different perspectives from other research traditions.

If students were 'empowered' by content, then it would follow that the more content we throw at students, the more empowered they would become. However, we know from experience that this is not the case. Students often feel swamped by content and as this feeling grows, the likelihood of them retreating into the 'safe haven' of rote learning also increases. This then seems to drive teachers to support this approach and we end up with the familiar cycles of non-learning (Kinchin, Lygo-Baker, & Hay, 2008). In such a scenario, the power that might have been found within the acquired knowledge disappears along with any appreciation of its structure or function beyond passing the examination. This is unlikely to generate excitement about either learning or teaching. When students are interested or excited with the curriculum, they are more likely to develop other positive emotions towards their learning that help to maintain active engagement (Rowe et al., 2013).

IN CONCLUSION

The knowledge structures approach may give the impression that the emergence of the 'expert student' can be achieved through a rather mechanistic adherence to structural protocols that could be mimicked to offer an appearance of expertise as a subversive ploy by a strategic student. The recognition of the expert student as more than adherence to protocols is helped by the view offered by Reid et al. (2011: 122) who address this by considering the expert student to have made a commitment to studies that goes '*beyond studying aspects of their discipline simply because they are part of the curriculum*' and '*are aware of the role and importance of their expanding knowledge*'. This may include efforts to integrate characteristics of their future profession within their current studies. This then goes beyond the purely cognitive to accept the importance of the affective domain in learning.

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