Developing professional knowledge during initial design and technology teacher education

This article seeks to identify the components which make up teachers' professional knowledge:

• subject content knowledge

• pedagogical content knowledge

• curricular knowledge

• school subject knowledge.

"I don't think anything quite prepares you for teaching in a class does it?" (ITT technology student)

Introduction

The greater involvement of schools in the professional development of new teachers makes it increasingly important to establish a common framework of understanding between students, school staff and lecturers in higher education. This understanding naturally covers common expectations of subject teaching competences to enter the profession, such as those published by DATA (1995). School-Higher Education Institute (HEI) partnerships have existed for years, but an increased use of subject 'mentoring' in initial teacher education means it is useful also to extend our common understanding to a fuller discussion of the different components which make up teacher professional knowledge. Staff at the Centre for Research into Teacher Education (CRETE) at the Open University are working to develop such a framework of teacher professional knowledge and are researching how aspects of such knowledge (or the lack of them!) impact on school teacher performance. More research needs to be done, but I suggest here some preliminary ideas of a framework which could help discussion and lead to shared language amongst the different 'players'; students, school-based mentors and HEI tutors.

Applebee (1989, p217) notes that "when we start to teach a new subject one of the most powerful influences on what we do is our memory of how we were taught." However, the relatively new subject of design and technology does not have a curriculum history long enough for those involved to have a common and shared 'memory' of how the subject 'should' be taught as may

be the case in science or mathematics. When they begin their courses, students have quite different 'personal subject constructs' about what they believe design and technology education is for and how it should be taught, and come into the profession with quite different subject knowledge strengths. Establishing some shared agreement about what the categories of teacher professional knowledge may help to facilitate the discussions between new teachers and their more experienced colleagues.

Categories of teacher professional knowledge

Since the mid-1980s there has been considerable discussion and a growing body of research on the forms of knowledge required by teachers in performing their role (Shulman and Sykes 1986; Shulman 1986; Grossman Wilson and Shulman 1989; McNamara 1991). These different forms of teacher knowledge have been usefully summarised by McNamara (1991, p115), and I present them in an adapted form here:

Subject content knowledge
Design and technology is a very broad subject. However, teachers need to have a good understanding of a substantive part of their subject to serve their pupils properly.

• If the aim of teaching is to enhance children's understanding then teachers themselves must have a flexible and sophisticated understanding of subject matter knowledge in order to achieve this purpose in the classroom.

The understanding of subject must be 'flexible and sophisticated' to include the ways in which the subject is conducted by academics within the field, "to draw relationships within the subject as well as across disciplinary fields and to make connections to the world outside school" (McDiarmid et al 1989, p193).

• Teachers' subject matter knowledge influences the way in which they teach, and teachers who know more about a subject will be more interesting and adventurous in their methods and, consequently, more effective. Teachers

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with only a limited knowledge of a subject may avoid teaching difficult or complex aspects of it and teach in a manner which avoids pupil participation and questioning and which fails to draw upon children's experience.

Pedagogical content knowledge
This knowledge is often given labels such as 'subject application' in DFE documents (DFE 1992), but I use here the term 'pedagogical content knowledge' after Lee Shulman (1986).

- At the heart of teaching is the notion of forms of representation and to a significant degree teaching entails knowing about and understanding ways of representing and formulating subject matter so that it can be understood by children. This in turn requires teachers to have a sophisticated understanding of a subject and its interaction with other subjects.

Shulman states:

"Within the category of pedagogical content knowledge I include, for the most regularly taught topics in one's subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations and demonstrations – in a word, the ways of representing and formulating the subject that make it comprehensible to others." (Shulman, 1986)

Curricular knowledge
There are currently at least four published schemes for teaching national curriculum design and technology: Staffordshire Technology Education Project (STEP), Nuffield Design and Technology, the Technology Enhancement Project (TEP) and the Royal College of Art Schools Technology Project (RCA). All teachers need to be aware of these and other curriculum materials and resources.

- Knowledge of subject content is necessary to enable the teacher to evaluate text books, computer software

and other teaching aids and mediums of instruction. This is the materia medica or pharmacopoeia, as Shulman puts it, from which teachers draw their equipment that present or exemplify particular content.

School-subject knowledge
To these types of teacher knowledge I would wish to add 'school-subject knowledge' (see Banks et al 1995)

- By altering technology to make it accessible to learners, a distinctive type of knowledge is formulated in its own right – 'school design and technology'. In the same way that school science has differences from science conducted outside the school laboratory, so school design and technology is different from design and technology as practised in the world outside the school.

As a 'subject designed by committee', the school knowledge of design and technology is particularly specific and rarely exists as a coherent body of knowledge outside the classroom. But the subset of technological knowledge which is 'school design and technology' is a function of the schooling process and so would exist even without a national curriculum to guide its formulation. 'School knowledge', in the way it grows out of any general body of knowledge, is inevitably changed. It is codified, partial, formalised and ritualised. Learning in that context is assumed to be programmable, defined in the form of a text, syllabus or national curriculum, with a conception of learning that implies a beginning and an end, an initial state and a final state. However, knowledge in general can rarely be sequenced in the same way as school knowledge and, generally, learning is far from being linear.

These different categories of teacher knowledge for design and technology teachers are summarised by Figure 1. The diagram tries to indicate the *synthesis* of these types of teacher knowledge and I recognise the inadequacy of the picture. One might initially see 'school knowledge' as being intermediary between subject content knowledge (knowledge of design

and technology as practised by different types of technologists) and pedagogical content knowledge as used by teachers ('the most powerful analogies, illustrations, examples, explanations and demonstrations'). This would be to underplay the dynamic relationship between the categories of knowledge implied by the diagram. For example, teachers' subject knowledge is enhanced by their own pedagogy in practice and by the resources which form part of their curricular knowledge. What teacher has not confessed to only really understanding a topic when they had to teach it to others! All these types of teacher professional knowledge are strongly influenced by the personal subject construct of the teacher.
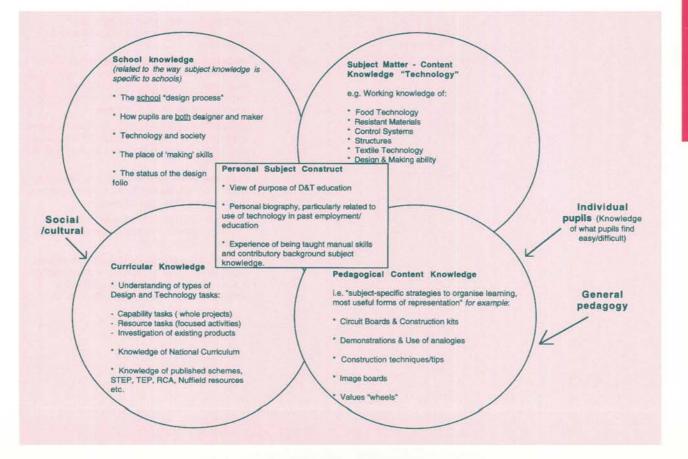
Personal subject construct
The past experience of learning technology, a personal view of what constitutes 'good' teaching and a belief in the purpose of design and technology for all underpin a teacher's professional knowledge. This is true for any teacher. Student teachers have to question their personal beliefs about their subject as they work out a rational for their

classroom behaviours. But so must those teachers who, although more experienced, have undergone profound changes of curriculum emphasis during their career. Figure 1 is useful in trying to clarify the different aspects of professional knowledge which student teachers need to develop as they move from novice to expert.

Using the framework
Observations and interviews with a number of novice design and technology teachers in different schools and on different courses across England and Wales has given a degree of confidence that the categories of professional knowledge illustrated in Figure 1 are meaningful (Banks 1996). The OU Professional Development Programme for mentors (OU 1994) points out that part of sharing practice is establishing a vocabulary, a 'shared language of analysing classroom practice'. There is a need to be able to 'see' what is going on in a classroom, to be able to describe it, and to begin to analyse it. Unstructured observation is difficult to analyse and becomes what Copeland has called 'a bewildering kaleidoscope of people,

Figure 1

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behaviours, events and interactions' (Copeland, 1981, p11).

"At first, students have been baffled by the specialised vocabulary used to describe both the teaching skills and the training process. 'I found the jargon the most daunting aspect at first,' confessed Alicia Selly, a Postgraduate Certificate in Education student on her final teaching practice. 'But once you start thinking in those terms, it soon becomes much easier". (Kirkman, 1990, p 26)

Similarly, a shared understanding of the different aspects of the professional knowledge of a design and technology teacher helps to provide a common basis for discussions between the different partners; student, mentor and tutor (See Banks, 1992). The framework shown in Figure 1 provides a way of opening up a dialogue to focus on the strengths of a teacher, to identify their professional development needs and to understand why their personal view of design and technology influences their behaviour in school and consequently the learning of their pupils.

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