"No One Forgets a Good Teacher!" – What do 'Good' Technology Teachers Know?

Abstract
In England and Wales secondary teachers are required to have at least two years of their first degree in the subject they wished to teach. Yet technology is well known for the breadth of subject knowledge it encompasses and the limited way in which degree courses provide for the scope needed for school technology. Is subject knowledge, often the driver of both pre-service and in-service course design for technology teachers, really so crucial?

This paper reports on a pilot empirical study conducted with technology initial teacher education students from the Open University and Brunel University in the United Kingdom. A framework for the teacher knowledge possessed by these students in terms of subject knowledge, pedagogical knowledge and 'school' knowledge is considered and the relative impact of such 'self awareness' of their teaching is discussed.

"It's quite a challenge making fractional distillation more interesting than sex"

Introduction

"It's quite a challenge making fractional distillation more interesting than sex" and "No one forgets a good teacher" are two examples of advertising slogans which have appeared in the press since 1993 trying to persuade people to enter the teaching profession, especially those with qualifications and experience in technology. In early December 1998 the UK Minister of Education, David Blunkett, announced that he was introducing a new deal for teachers:

> "I'm going to teach them my three R's [...] To recruit, to retain and to reward high performance" [...] At the heart of the proposals is the introduction of a Civil Service style fast track for top graduates, guaranteeing them a rapid route to promotion and higher rates of classroom pay.
> (Bright and Wintour, 1998)

The link between a 'good degree' and being a 'good teacher' is taken by the minister as axiomatic. Degrees from universities in the UK are usually classified into six levels the top two being 'good'. The Teacher Training Agency (TTA) in England has established the criterion of the number of students on a post-graduate initial teacher training course who hold such a 'good' class of degree as worthy of being published in tables of success. But how significant is content or subject knowledge for creative and effective teaching? What links can be made between a teacher's knowledge and the associated pedagogic strategies and practices to ensure successful learning? There are, after all, very few degree subjects that match neatly the subject knowledge and skills base needed for school technology. How can we help new teachers to conceptualise these relationships and reflect on how different sorts of 'teacher knowledge' impact on their teaching?

> "The 1991 national survey of all 317 initial teacher education courses in England and Wales [...] revealed that over 70 per cent of those courses that claimed to be underpinned by a particular philosophy described that as being based on the principles of the reflective practitioner [...] Five years on, the term has achieved even wider currency, and the notion of reflectivity has become incorporated into many teachers' own views of what it means to be a professional."
> (Furlong and Maynard, 1995 p37)

Despite the widespread use of the term 'reflective practitioner', there is little agreement about what is meant by 'reflective practice'. Calderhead (1989) has described the notion as a slogan rather than a principle. We would agree with McIntyre (1993) that often a systematic approach to reflection is of limited value in the earliest stages of professional development where students have neither the time nor the breadth of experience to do more than experiment with the approach. However, we would strongly argue that such experimentation with reflection on practice would be more successful if the student is provided with a usable framework that will help them consider aspects of their professional knowledge in the widest sense and grounded in their subject.

It was with a view to discover the impact of an enhanced awareness of teacher professional knowledge on school technology teaching and learning that a joint project was established between the Open University and Brunel University. Both universities offer initial teacher education courses enabling the student teachers to teach school pupils aged 11 to 18 years. These student teachers were provided with a framework for analysis of their teacher professional knowledge. We report here how these technology student teachers used the framework and came to think through the implications of their understanding of the teacher role.

A framework for conceptualising teacher professional knowledge

In this study of the self-awareness of teacher knowledge in pre-service technology student-teachers, we drew on the work of our

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colleagues in the Centre for Research and Development in Teacher Education (CReTE) at the Open University (see Leach and Banks, 1996; Moon and Banks, 1996; Banks, 1997a; Banks, Leach and Moon, 1999). By linking together four clusters of ideas they have produced a graphical framework which is helpful in visualising the different aspects of teacher knowledge. The ideas were: the curriculum orientated work of Shulman (1986); the cognitive approach of Gardner (1983, 1991) and the interrelated tradition of didactics and pedagogy in continental Europe (Verret, 1975, Chevellard, 1991). They also considered how the community of practice of schools influences a teacher's professional development and draw on ideas of situated learning developed by Lave (1988, 1991). The outcome of this work was a pictorial model of teacher professional knowledge (Figure 1).

One might initially see 'school knowledge' as being intermediary between subject knowledge (knowledge of technology as practised by different types of technologists for example) and pedagogical 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, a teacher's subject knowledge is enhanced by his or her own pedagogy in practice and by the contextual expectations which form part of their school knowledge. Which teacher has not confessed to only really understanding a topic when they were required to teach it to others! It is the active intersection of subject knowledge, school knowledge and pedagogical knowledge that brings teacher professional knowledge into being.

Lying at the heart of this dynamic process are the 'personal constructs' of teacher and pupils, a complex amalgam of past knowledge, experiences of learning, a personal view of what constitutes 'good' teaching and belief in the purposes of the subject. This all underpins a teacher's professional knowledge. This is as true for any teacher. A student teacher has to question his or her personal beliefs about their subject as they work out a rationale for their classroom behaviours.

The diagram has some similarities with the developmental model of 'pedagogical content knowing' proposed by Cochran, DeRutter and King (1993), but is simpler in form. Since the mid 1980s there has been a growing body of research into the complex relationship between subject knowledge and pedagogy (Shulman and Sykes 1986; Shulman 1986, 1987; MacNamara 1991, Turner-Bisset,

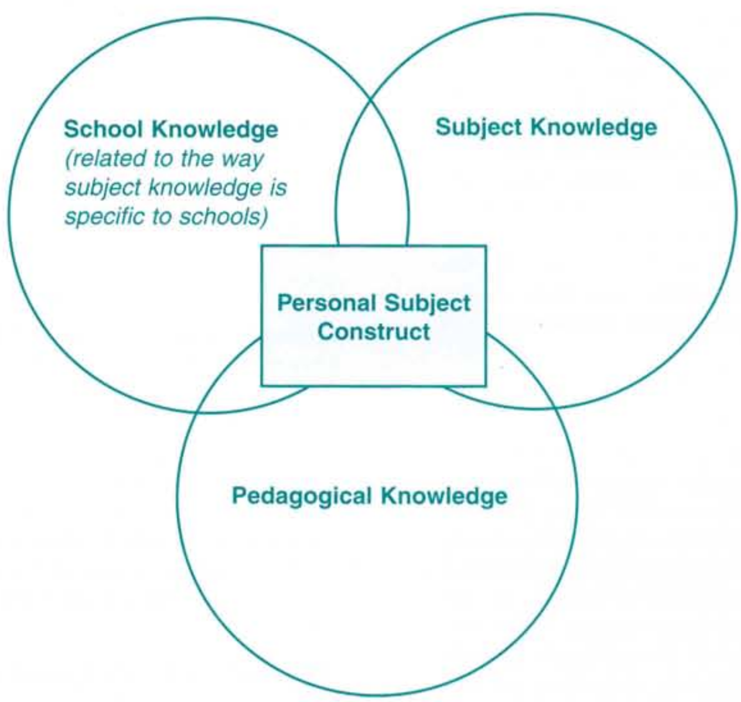

Figure 1

1999). Shulman's original work in this field has been an obvious starting point:

> "how does the successful college student transform his or her expertise into the subject matter form that high school students can comprehend?"
> (Shulman 1986)

Like Cochran, DeRutter and King (1993), but from our perspective of technology teaching, we are critical of Shulman's apparent emphasis on professional knowledge as a static body of content, lodged in the mind of the teacher. Pedagogical content knowledge thus defines the subject specialists' task as that of discovering:

> "the most useful forms of analogies, illustrations, examples, explanations, and demonstrations – in a word, the ways of representing and formulating the subject in order to make it comprehensible to others."
> (Shulman, 1986, p.6)

As such Shulman's work tends to devalue skills and processes, leaning towards a view of cognition that sees knowledge as an external body of information, assuming an essentially teacher centred pedagogy contrary to our expectations in technology education:

> "The key to distinguishing the knowledge base of teaching lies at the intersection of content and pedagogy, in the capacity of a teacher to transform the content knowledge he/she possesses into forms that are pedagogically powerful and yet adaptive to the variations in ability and background presented by the students"
> (Shulman, 1987, p.15)

Paramount amongst school subjects, technology is characterised by a pedagogy where there is no 'right answer' but rather different responses to the same problem are valued – some judged better than others. Compared with other subjects such as science and mathematics, perhaps a teacher of technology is less in a position of being a 'fount of all wisdom' but rather a guide to help a pupil to (as Barlex would put it) 'Design what they Make and Make what they have Designed'. This is not to deny the important role for subject knowledge in technology, nor to suggest that the teacher is not an important source of information, but the teacher's knowledge and expertise need not be a brake on the speed or direction of the pupils' development or creativity. For example, in electronics a pupil can treat an amplifier as a 'system element' without knowing or needing to know the details of the physics of its operation. Similarly a pupil can make artefacts using a polymer without needing to know much more than the underlying concept of giant molecules and the interaction between the chains. However, that pupil may indeed need to know more sophisticated ideas about amplification or plastics as their interest in their design problems develop. A teacher who is able to engage them in a conversation at an appropriate level will be better able to match the curriculum to the pupil.

In contrast to Shulman, Gardner's (1983) work is rooted in a fundamental reconceptualisation of knowledge and intelligence. His theory of multiple intelligences allows us to view pedagogy from a perspective on student understanding. In common with the ethos of school technology, the focus shifts from teacher to learner, from technique to purpose. The five 'entry points' which Gardner proposes for approaching any key concept – narrational, logical-quantitative, foundational, experiential and aesthetic – do not simply represent a rich and varied way of mediating a subject. Rather they emphasise the *process* of pedagogy and a practice which seeks to promote the 'highest level of understanding possible'. (Gardner 1991)

School technology is different to technology as conducted in universities or in industry. The concept of 'didactic transposition', a process by which 'subject knowledge' is transformed into 'school knowledge', enables us to consider the way that schools as institutions construct their own sort of knowledge. The CReTE ideas here have been informed by the work of Verret (1975) and Chevellard (1991).

Finally, Lave's (1988; 1991) research with adult learners engaged in new learning situations focuses on the social situation or "participation" framework in which such learning takes place, a process of involvement in the communities of practice'. To become a full member of the 'community of practice' of technology teachers requires access to a wide range of teaching expertise, 'old-timers', and other members of the teaching community; and to information, resources and opportunities for participation in communities of practice (see Lave and Wenger 1991 p.101).

Lave's work is of particular significance for school technology because the community of technology teachers is having to cope with major changes in the subject that it is teaching. The difficulties experienced by teachers can to some extent be gauged by looking at the range of publications produced between 1989 and 1995 aimed at clarifying the situation for the teacher. These included a complete revision of the National Curriculum Orders for Design and Technology (D&T)

(see Barlex 1998). One of the aims of the design and technology curriculum in England and Wales is to provide a broad and balanced experience of designing and making using a range of materials and technical components.

Pupils should be given opportunities to develop their design and technology capability through:

a) Assignments in which they design and make products, focussing on different contexts and materials and making use of:

- resistant materials
- compliant materials and/or food.

Taken together, these assignments should include work with control systems, e.g. *electrical, electronic, mechanical, pneumatic*, and *structures*:

- focused practical tasks in which they develop and practise particular skills and knowledge
- activities in which they investigate, disassemble and evaluate familiar products and applications. (DFE/WO,1995, p6)

However, there is more to this breadth and balance than merely the materials and components used (see Barlex 1995). Within the designing and making process there are features which will appeal to different degrees to a teacher according to the specialism and professional history of that teacher. Teachers will have greater familiarity with and preference for particular areas. The list below identifies such features and the often-articulated rationale for its significance. The difficulty in achieving breadth and balance arises when that significance becomes instead dominance (see Figure 2).

Ideally a balanced designing and making assignment will call significantly on each of these features, though perhaps not in equal measure. But, if a teacher is strong in just one or two aspects, or believes that one is more significant than any of the others, the breadth and balance within the designing and making experience is lost. Many technology teachers were trained initially as craft teachers and their work has been generally criticised by the Office for Standards in Education (OFSTED).

> "…in general pupils' attainment in designing lags behind that in making. This is because pupils are either not introduced to a sufficiently wide range of designing strategies [...] or are not taught to use them effectively. Pupils are generally confident where work is closely directed by the teacher, but less so when working independently to their own plans, with little awareness of how their work will develop in the later stages of their projects."
> (OFSTED, 1998)

The student teacher may be caught in a dilemma. Clearly there is the possibility, if not probability, that student teachers in school based training will be introduced to practice that is skewed because of the previous history of the supporting teachers in that school. So the school knowledge (see Figure 1) developed by participation in the community of practice of the school may be at variance with what is considered to be best practice by the college. Important here is not merely the obvious point that school experience is vital for student-teachers but that their learning is hampered if the meaning of the activities of teachers (in this case) is not made 'transparent'.

This study was conducted as an attempt to evaluate how transparent different aspects of teacher professional knowledge was to student technology teachers and to see how useful the framework was as a tool to help them reflect.

Methodology

Thirteen technology student teachers in the final year of their course from the Brunel University and the Open University were interviewed and shown a blank outline of the CReTE framework (Figure 1). The different elements of the framework were explained to

Figure 2 Developing a balanced approach.

• Aesthetics	The appearance is crucial. It says everything about the product.
• Communicating skills	Unless they communicate their ideas nothing will be accomplished.
• Design procedures	Without the procedural competence of design nothing can be achieved.
• Making skills	But if they can't make it it's a complete waste of time.
• Technical understanding	If it's not technically sound it just won't work.
• Values	Without an appreciation of the values implicit in the endeavour the whole exercise lacks worth.

them and, in relation to the work on teaching placement, they were asked the following:

- What subject knowledge (about design and technology) do I have/need to get for the teaching?
- What pedagogic knowledge (about teaching methods) do I have/need to get for the teaching?
- What school knowledge (about ethos, procedures, significance of some activities) do I have/need to get for the teaching?

The students were also asked to consider their 'personal subject construct' as outlined above.

The Open University student teachers gave their views verbally and their points were noted onto the blank diagrams. The students from Brunel University were asked to produce a short piece of writing 'in which you reflect on some teaching that you did in your last practice in which you can comment on each of the three features'.

Results

As might be expected, the students used the framework with a range of levels of sophistication. For all students it provided a useful focus for debate, and in particular the nature and extent of school knowledge was discussed by the Brunel students using Figure 2. The views of seven students who either contributed a piece of writing or made significant comments are included here.

School knowledge

First, some ideas about 'school knowledge':

James: *It is important that I discover the expectations within the department [...] This may be as pedantic as the layout of work, something I perhaps may not entirely agree with, but [...] something they gain marks for after I have left, then they will be required to be familiar with it. My own teaching can then work around this.*

Frank: *After a few weeks within the department I noticed that the department ethos, or approach to teaching was the same across the board [...] The projects from Year 7 upward were very closed in nature and pupils were led by the hand through each assignment. This resulted in the pupils producing an end product identical to everyone else. I must admit it was to a high standard and I learned a lot about subject knowledge, especially in the area of woodwork practices and processes. It seemed to me that the department was setting Design and Make assignments that were in fact Focused Practical Tasks.*

Karen: *After working in [name of school] it is very easy to figure out what the subject teachers are like and the commitment to the school and pupils. The following points are things to look out for in the next school.*

Karen goes on to list 23 bullet points. All but two we would classify as 'school knowledge'. She 'looks out' for wall displays, exam results, attitudes of the pupils and teachers, schemes of work and a range of school polices such as SEN, homework and detention.

Christopher: *In school you have to work in a particular way. For example the control software package configures the way I have to work and the pupils have to think because that is recommended by the exam board.*

Vincent: *In this school the department is driven by the exam. That is all that is important. So I think technology here is too individualistic where industry is social.*

Subject knowledge

All the students could identify subject knowledge gaps that they had. Indeed the rectification of technology subject gaps is a pre-occupation on many teacher preparation courses at all levels (see Banks 1997a and b). The Open University students in the sample were working as school technicians and felt relatively confident:

Colin: *There is no 'big hole' in my knowledge dye to being a technician but sometimes I forget the 'easy stuff'!*

Competence in 'Graphics' was a declared problem for three of the students. Two of them said that they lacked sufficient knowledge of electronics for more than basic work.

Frank: *I knew I was lacking in some of the graphics subject knowledge, so I spent a great deal of time and effort getting up to scratch on them.*

Pedagogical knowledge

Vincent and Christopher had a clear view of how the pupils' enthusiasm for technology and the quality of their work was intimately bound up with the teaching strategies deployed.

Vincent: *Pupils take their cue from the teacher. There is a lot of 'street cred' for the subject in this school – more so than Art – but it is just as creative. However, there is very little group discussion used.*

Frank: *During my last school practice I worked with a Year 10 Graphics group. I found this group to be very passive and generally switched off to the subject [...] There was a lack of imagination being*

demonstrated in their work, which I felt, was coming from the way the subject was being presented to them [...] I introduced group-work, which they had not experienced in design and technology and let them give their opinions. We explored ways we could use these skills in presenting what we wanted to say in graphics [...] The pupils responded very well and produced many varied and imaginative results. In addition [...] I set a competition to produce a graphic image. This was very open, with the only criteria being that it was interesting to the eye or not as the case may be. This really was difficult for the pupils to take on board initially, as they wanted to know what I wanted as a result. In the end they produced a very good series of images, some 3D, some computerised, some with alternative backgrounds. The approach to teaching in a different way from chalk and talk seemed to awaken this group of pupils.

Khan: *I felt that the pupils required a change of task setting and a more 3D approach to graphics [...] I allocated time for the pupils to create prototypes or models from cardboard of the designs they had generated and present their museum designs [the context set up by Khan], through their graphics based work and models to a board of directors (the rest of the class) therefore relating the project to real life contexts of designing in society. I left the presentation styles up to the individual pupils but did incorporate some input [...] on presentation techniques using computer graphics and boards. It was expected that the pupils would give a 2-3 minute presentation. The end result was a positive change of all the attitudes of the pupils. They exhibited a general willingness to learn and an interest not only in their own work but that of others, especially the presentation where the pupils generated constructive criticism and reacted well to others discussing their work.*

Personal subject construct

The nature and quality of the answers showed the range of personal subject constructs held by the student teachers and they often mentioned how it conflicted with the subject construct held by their school mentor or other people in the school technology department. Vincent, like Kahn in the quote above, saw technology as being closely linked to 'real-life' and vocational preparation. Christopher, in contrast, saw technology as personally empowering for the pupils. They should understand 'how to wire a plug and not be scared to do things'. He wanted pupils to 'have a go' to gain personal confidence.

Conclusion

Although the extent of this pilot study is limited in the number of students who took part, it is significant in that the students across two quite separate institutions, with students from very different parts of the UK, could identify with the concepts outlined in the CReTE framework. It is clear from the above extracts and examples that they could use the categories as a means to reflect on their practice. The investigators could, in turn, use the diagram as a way to group aspects of teacher knowledge when the students described both their own practice and that of their colleagues in school. The framework has been used at a number of in-service events throughout the UK and in other countries and many teachers have also been sympathetic to the model and how it closely relates to aspects of their real-life practice.

Moreover, the sophistication of response shown by some seems to match well to those who are developing into effective teachers. Frank, for example, showed a deep insight into a number of aspects of teacher knowledge and was able to bring such awareness into developing his teaching. Karen, interestingly, was also thought to be an effective teacher and was given employment by her placement school. Her awareness was almost exclusively in the area of 'school knowledge'. This raises the question is a 'good' teacher merely one who is seen to be good at what schools as institutions value and find important? Both Karen and James, however, were able to be self-aware of the community of practice of technology teachers that created the local 'school knowledge' that surrounded them and, to some extent, subvert it. As James put it, 'My own teaching can then work around this'.

The positive impact on pupil learning in technology due to student teachers that are better able to reflect on their practice seems clear from the extracts presented here. As McIntyre (1993) suggests, reflection by novice teachers is very difficult. However, we believe that this study has shown the framework is a simple yet effective 'way in' to begin the discussion of the different aspects of teacher knowledge. Indeed, the discussion of the model will itself promote an insight into the various aspects that contribute to the professional role of an effective technology teacher.

An international collaborative project is being developed to explore the usefulness of this framework. Although the teaching conditions and context may be different all teachers share the challenge of how best to develop their professional knowledge and skill. This study may throw light on ways to develop the reflection essential to this endeavour.

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