Open Primary Technology: Teacher Education for Teachers of 5–11 Year Olds by Open and Distance Learning

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Introduction

This paper considers the professional knowledge required by elementary school teachers of technology. In particular, it focuses on two open and distance learning courses offered by the United Kingdom's Open University. These are *E626 Design and Technology in the Primary Curriculum* which is a course for experienced teachers, and *E880 Teaching in Primary Schools: Technology Module* a subject-specific element in the new ITT Primary course.

The Open University was founded in 1969. For more than twenty-five years it has produced distance teaching courses which combine text, video and audio elements in a mixed-media format. Students are able to study at home or their places of work for degrees at undergraduate and postgraduate levels and for a range of other vocational and professional qualifications. The university also produces resource packs of audio-visual and text material which are of general interest. In 1995 well over 200,000 people studied with the Open University. Through a long association with the BBC, which has its own production centre on the university campus in Milton Keynes fifty miles north of London, the Open University has earned a reputation for the high quality of its courses in both academic and production standards. Courses, which are designed and produced centrally, are supported by local part-time tutors through a network of study centres covering thirteen regions of the United Kingdom.the ages of 5 to 11 years, pupils in England and Wales study the same D&T curriculum. They undertake the following activities;

- assignments in which they design and make products;
- focussed practical tasks in which they develop and practise particular skills and knowledge;
- activities in which they investigate, disassemble and evaluate simple products. (DfE/WO, 1995, p2)

They work with a range of materials including stiff and flexible sheet material, reclaimed materials, textiles, food and construction kits. There is no fixed time for the study of D&T, but the quantity of work to be covered suggests that 1.25 hours per week are needed at the elementary school (Key Stage 2) level. There are two attainment targets; Designing and Making, and a programme of study specifies the design skills, making skills and the areas of knowledge and understanding which should be taught.

What Sort of Knowledge Do Primary Teachers Require?

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 & Shulman 1989; McNamara 1991). These different forms of teacher knowledge for design and technology teachers have been described elsewhere (Banks, 1996). I summarise the categories here:

Subject Content Knowledge

As is indicated in the introduction, design and technology in England and Wales is a very broad subject. However, teachers need to have a good understanding of a substantive part of the subject to serve their pupils properly.

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, p.193).

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 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 government documents (DfE 1992), but I use here the term 'pedagogical content knowledge' after Lee Shulman.

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 makes it comprehensible to others.' (Shulman, 1986)

Curricular Knowledge

There are currently at least four published schemes for teaching national curriculum Design and Technology for High School pupils in England and Wales but currently only one, the Staffordshire Technology Education Project (STEP), for elementary schools.

- 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 technology'. In the same way that school science has differences from science conducted outside the school laboratory, so school D&T is different from 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

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, formalized 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 primary teachers of D&T and the elements covered within the Open University courses 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 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, a teachers subject knowledge in 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 D&T for all underpins a teacher's professional knowledge. This is true for any teacher. In particular a student teacher in ITT has to question his or her personal beliefs about their subject as they work out a rational for their classroom behaviors. 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 a student teacher needs to develop as he or she moves from novice to expert.

How Do the OU Courses Cover These Types of Teacher Knowledge?

Personal Subject Construct

From Figure 1 it is apparent that the 'personal subject construct' is initially tackled directly in both courses by asking the question "What is Technology?" The INSET (E626) course spends a considerable time in addressing the relationship between *design* and *technology* and in considering why technology should be in the elementary school curriculum. It gives a four point rationale:

- Pupils need to be exposed to part of our culture in the *technological world*
- Pupils need to be informed citizens who are able to question *technology's influence in society*
- Children need to be aware of the *economic imperative* which suggests that technological knowledge is important for wealth creation
- A problem-solving process which comes naturally from technological tasks is a good vehicle to promote *learning-related* activities.

The ITT course takes a similar line but spends more time asking the student-teachers to consider their own experiences of design and technology.

Figure 1

Open university Technology Education Courses

E626: Design and Technology in the Primary Curriculum (INSET)

E880: Teaching in Primary Schools-Technology Module (ITE)

School Knowledge

(related to the way subject knowledge is specific to schools) for example:

E626: Curricular views about the nature of technology; Matching of activities to the national curriculum; What opportunities for learning does technology offer?

E880: Design and Technology in the national curriculum

Subject - Content Knowledge "Technology" *for example:*

E626 & E880: A Technology Activity; "The problem of the two eggs"
E626: The Process of Design, The product Cycle, Kinds of modelling Systems Thinking
E880: Technological capability for teachers; Structures; Control & Energy; Food

Personal Subject Construct

E626: What is Technology?; The relationship between Design and Technology?; Why is Technology in the Curriculum?

E880: What is Technology? Your own school experience of Technology

Curricular Knowledge

i.e knowledge of resources for the classroom, for example:

E626: Case Studies of topics on Homes, Hats ads Systems (growing cress)

E880: Case Studies; Introducing Design and Technology tasks to children; Developing children's ideas; Gender issues.

Pedagogical Content Knowledge

i.e "subject-specific strategies to organise learning, most useful forms of representation" for example:

E626: Case studies; Simulating a Commercial activity; questioning; Planning for the development of Technological capability.

E880: Case Studies; Introducing Design and Technology tasks to children; Developing children's ideas; Gender issues.

School- Subject Knowledge

It will be apparent that the wide view of design and technology adopted in England and Wales embraces many aspects, such as food technology, not considered as part of the subject area in other parts of the world. In the United Kingdom is a strong tradition of teaching a range of curriculum subjects using a "topic" approach. A topic such as "Transport" or "Vikings" will both relate to maths and D&T, for example, as they do to the more obvious subject links of science and history respectively. The OU courses provide guidance to ways in which classroom activities within topics can link to coverage of the national curriculum.

Curricular Knowledge

There are currently only limited examples available of curriculum resources for design and technology and very few published schemes for elementary schools. In the UK, government authorities give guidance to what they consider to be good practice in teaching and learning, but generally do not produce classroom materials for teachers to use. That is left to commercial interests, and the swiftly changing curriculum of recent years has made publishers reluctant to commit resources to the production of high quality materials which teachers might consider to be 'out-of-date' too quickly. E880 and E626 have tried to illustrate the use of curriculum resources by giving a selection of case-study examples, using both video and written descriptions. Both exploit the case-study of the manufacture of model Homes to show Lego, Quadro and simple construction techniques in wood strip and card. E626 in addition shows the production of an artefact (a hat) and an example of a system in the growing of cress. E880, being a later course, was able to use illustrative written resource material from the STEP published scheme.

Pedagogical Content Knowledge

The case studies are also exploited to illustrate teaching and learning strategies. The way that teachers need to consider the planning of work, the careful introduction of the tasks to children and their questioning of pupils during the supporting of the practical work is considered in considerable detail. Experienced teachers are already very used to developing children's ideas in art and are adept in the classroom management issues associated with such practical work. However, supporting children through the processes of design and technology is something which is new

to many teachers and the confidence to do that is encouraged by the student-teachers themselves engaging in a technological task.

Subject Content Knowledge

The case study examples contribute to the student-teachers subject knowledge and understanding. However it is important for teachers to understand how D&T processes impact on the subject by they themselves engaging in a project. In this way the appropriate pedagogy for design and technology is underlined and the various elements of professional knowledge are brought together. The following is a extract from both courses which share the same practical task:

Reg's Problem

This is the story of Reg who lives alone in a first-floor flat with access via stairs. He is healthy and agile enough to take a twice-weekly walk into town where he buys his food and other supplies. He carries his shopping in a soft bag that he finds far more convenient that a rigid basket. He has just one problem with this: he likes to buy just two, fresh free-range eggs from the local health shop each time he goes to town. He has tried using a conventional six-egg box but feels it unnecessarily bulky. He has had several mishaps and, for various reasons, feels that an improved carrier for two eggs must be possible (see figure 2)

1 Undertake the following design brief:

   Design and make a prototype of a two-egg carrier that will satisfy Reg's need. Record your feelings about undertaking the task as well as recording the progress of your design. It is important that you do this activity practically [...]

2 Next, take time to reflect on how you worked on the given task.

3 Now, relate the experience you have just had to the way you will need to set up learning experiences for the children you teach, that is, to your teaching strategy. *(Open University,1994, p7–9)*

The courses are able to use the students experience on this project to consider issues of motivation, practical knowledge, pedagogy, use of resources and the coverage of the national curriculum.

The synthesis of aspects of teacher knowledge implied by Figure 1 is also illustrated by the cross-referencing to different types of knowledge in the above descriptions. An activity such as ’Reg’s Problem can initiate discussion of subject knowledge, pedagogy and affect a student’s ’personal subject construct’.

Conclusion

This paper has outlined the way the various aspects of teacher knowledge required for teaching design and technology can be covered in open and distance learning courses. The audio-visual case studies, the academic materials and the practical activity can all be investigated at home. However, student-teachers are not completely isolated on Open University courses. All courses have an element of face-to-face tutorial provision which are increasingly being supplemented by contacts made using computer conferencing. In the courses considered here, the students are given a number of opportunities to meet and discuss their use of the materials and classroom strategies for teaching design and technology. Open and distance learning is a cost-effective way of supplementing conventional tuition which enables student-teachers to work at times and locations convenient to them and which impacts to a limited extent on their professional and personal lives. Such courses have much to offer in the daunting in-service education task facing us in the implementation of high quality technology education into elementary schools.

(A picture is missing here. “Picture: “The problem of the Two Eggs“)

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