Primary School Teachers as Mentors of Subject Knowledge

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Introduction
In recent years - and particularly, since the introduction of the National Curriculum - British primary school teachers' alleged lack of subject knowledge has become a matter of great interest and grave concern. A number of researchers, as Sanders has described, have directly questioned the adequacy of teachers' subject knowledge - particularly in the core curriculum areas of mathematics and science - while reports by those seen as 'close' to the government (e.g. Alexander, Rose and Woodhead 1992, Woodhead 1995) repeatedly stress the link between teachers' subject knowledge, the quality of their teaching and pupil achievement.

Unsurprisingly, teachers' difficulties with subject understanding have been reflected in recent reforms of Initial Teacher Training (ITT). As I pointed out in the previous paper, in Circular 14/93 (WO 62/93) the first three stated priorities for Primary ITT centre on improving teachers' subject knowledge. In addition, as a result of this Circular it is likely that student teachers will spend some time on their school experience focusing specifically on the teaching of 'subjects' and that teachers, rather than HEI tutors, will take responsibility for this work.

Asking teachers to become subject mentors may be seen by the government as one way of improving teachers' subject understandings - particularly, as Sanders has suggested, in relation to the facts, concepts and procedures of the subject areas they are required to teach. In this third and final paper of the symposium, I will take this issue of 'primary school teachers' and 'subject knowledge' one step further by directly exploring the question 'What aspect of teachers' subject knowledge should form the basis of students' school-based subject studies?'

Background
This paper draws on research carried out as part of a project funded by the Welsh Office. This project, which is current, aims to develop and disseminate materials which may be used by schools to support subject-based mentoring in the four core areas of the Welsh National Curriculum. Eight teachers recognised as having considerable expertise in the teaching of either Welsh, English, mathematics or science were invited to take part in this project. In order that teachers could participate in this project, schools were given a grant of £2,000 to allow the release of the designated teacher for the equivalent of approximately 18 days over the school year.

During the Autumn term the teachers took part in several INSET sessions which were designed to develop their understanding of student teachers'
learning needs and the processes of mentoring. In addition, teachers, along with lecturers from the University of Wales Swansea, Primary Post Graduate Certificate of Education (PGCE), met as individual subject groups to review the content of students' college-based subject studies - both from our own PGCE course and also from undergraduate and postgraduate courses based at other teacher training establishments. Each subject group consisted of two teachers and one lecturer.

At the end of the Autumn term teachers and lecturers in each subject group began collaboratively to devise activities which aimed to develop students' subject understandings while on their school experience. During the Spring and Summer terms several of these activities were piloted by the teachers with both PGCE and undergraduate students who were on block teaching experience in their schools.

As well as meeting in individual subject groups, a number of whole group meetings were held during the Spring and Summer terms in which subject specialists - that is, teachers and lecturers - negotiated a common 'perspective' with regard to the structure and format of activities, and discussed their progress and difficulties. In addition, during the Summer term, group members used these meetings as a forum to evaluate each others' activities.

As research officer I acted both as facilitator and observer at both subject group and whole group meetings: my intention was to help the subject specialists clarify their thinking whilst also ensuring the final pack of materials would have overall coherence. Notes were kept of subject specialists' discussions and responses, and at the end of the Summer term all members of the project group were interviewed. Recordings of these interviews were transcribed and analysed (approximately eight hours of recordings).

Teachers' personal subject knowledge

Initially, it is important to examine the descriptions or characterisations of teachers' subject knowledge proposed by researchers working in this field. Following the work of Schwab (1978) there appears to be general agreement amongst researchers that subject knowledge can be understood as incorporating two different dimensions: substantive and syntactic knowledge. Substantive knowledge is knowledge of the subject and will include the facts, concepts, procedures etc. of the subject area and also a knowledge of the way in which a particular body of knowledge is structured and organised. Syntactic knowledge is knowledge about the subject and incorporates a knowledge of the way in which a particular body of knowledge is generated and validated.

It has been suggested that if they are to be effective in their work then teachers need to have a 'flexible, thoughtful and conceptual' understanding of the subject areas that they teach (McDiarmid, Ball and Anderson 1989). It is not enough for teachers to be 'one step ahead' of pupils in terms of their subject understanding. Teachers need to be able to 'make connections' - to know about relationships between given
phenomena both inside and outside their field; how knowledge in their field is generated and validated; and about fundamental ideas and relationships that underlie interpretations of particular phenomena (McDiarmid et al 1989, p198). In addition, we have heard Sanders arguing that beliefs about the nature of subjects profoundly influence teachers' practice. This aspect, therefore, must also be incorporated into any discussion of teachers' subject knowledge.

Pedagogical content knowledge

But having a personal subject knowledge, however flexible and sound, is not enough. Teachers, it is claimed, need to find ways of transforming this knowledge in order to make it accessible to the pupils in their class. Shulman (1986) calls this knowledge - teachers' subject knowledge for teaching - pedagogical content knowledge. Shulman describes this knowledge as 'the most powerful analogies, illustrations, explanations and demonstrations - in a word, the ways of representing and formulating the subject that makes it comprehensible to others' (1986:9). McDiarmid et al (1989) maintain that appropriate representations and activities emerge from teachers' bifocal consideration of subject knowledge and pupils. Similarly, Grossman et al (1989) cite Calderhead and Miller (1985) who suggest that teachers interweave their prior knowledge of subjects with immediate knowledge of classroom realities to produce 'action relevant' knowledge. These researchers seem to suggest that in generating ideas for activities, teachers reconstruct their existing 'theoretical' subject knowledge in a form that meets the immediate 'practical' demands of the classroom and of pupil learning.

But, as Wilson, Shulman and Richert (1987) emphasise, pedagogical content knowledge cannot be gained simply by copying a repertoire of multiple representations of the subject matter. Rather, it is built up through the process of pedagogical reasoning - through planning, teaching, adapting instruction and reflecting on classroom experiences. Teachers understanding of subject knowledge, according to these researchers, has a powerful influence on how teachers transform and represent this knowledge. Wilson et al (1987) cite Hashweh (1985) who found that the representations of knowledgeable teachers reflected their deeper understanding of the topic - they were able to relate the specific topic to key concepts, principles and themes within the discipline. Similarly Grossman et al (1989) describe how in their research beginning teachers with graduate training in their field were more likely to stress conceptual understanding and syntactic knowledge - the 'whys' and opposed to the 'how tos'.

Process or Content?

It was these domains of teachers' subject understandings - personal subject knowledge (incorporating substantive knowledge, syntactic knowledge and beliefs about the nature of the subject) and pedagogical content knowledge (subject knowledge for teaching) - that were intended
to guide and structure an initial discussion concerning the content of
activities. That is, group members were asked to debate which of these
aspects of teachers' subject knowledge should form the basis of
students' school-based subject studies. But a consideration of these
domains, as we shall see, proved to be of only limited value. Indeed,
group members quickly dismissed this 'model' and chose instead to
discuss whether the activities they were to devise should aim to
develop students' understanding of how to teach specific aspects of
content or whether they should aim to develop their understanding of
fundamental processes associated with the subject area. At the
conclusion of this meeting group members had agreed unanimously that
activities should focus on 'process'.

In part this decision was pragmatic: activities which centred on
teaching discrete aspects of subject content would present schools and
higher education institutions (HEI's) with immense organisational
difficulties with respect to the placement of students. This factor
should not be underestimated - if science activities were to
incorporate tasks related to the teaching of, for example, the water
cycle, then this may necessitate subject mentoring being carried out
within a particular class or at least within a limited number of
classes. The effectiveness of subject mentoring could thus become
reliant on a particular teacher's perspective, understandings and
goodwill in undertaking this work.

For the English and Welsh specialists, a focus on 'process' appeared
logical and incontrovertible. Devising activities that were centred
around the processes of 'speaking and listening', 'reading' and
'writing' not only addressed organisational demands but also followed
the structure and 'covered the content' of the National Curriculum.
Activities devised by these groups aimed, for example, 'to develop the
student's understanding of the value of sounds and rhymes in pupils'
linguistic experiences' (Welsh) and 'to encourage the student to plan
and implement a variety of writing activities linked to different
curriculum areas' (English).

But the concern with process appeared more deliberate and purposeful
for the science group. Their decision to focus on aspects of scientific
investigation and the development of process skills derived from the
fact that this was seen as a fundamentally important aspect of pupils'
work in science and one with which teachers were still having
difficulty. One science specialist commented, 'Investigative work in
science has not been taken up by teachers ... we were thinking about
support for the teacher in science, even more than the student.' In

addition, the science group appeared to be influenced by considerations
of what they considered to be 'good' pedagogy and in this respect could
be seen to reflect child-centred approaches to teaching: their comments
were resonate of those expressed by teachers in the previous project.
For example, one science specialist maintained, 'Investigative science
is a must for good quality science. Otherwise if you have just content
it doesn't mean that the children are going to understand anything at
all. They might remember but if they don't investigate then there is going to be a much better chance they are going to understand.'
The science groups' activities, therefore, centred on developing students' understandings in relation, for example, to 'taking and recording measurements', 'interpreting data' and 'communicating findings'. While these activities could be used with whatever aspect of substantive content was relevant to students' current teaching experience, it did mean that the teaching of three strands of the National Curriculum programmes of study for science - 'life processes and living things', 'materials and their properties' and 'physical processes' - were not directly being addressed.
The mathematics group appeared to be adopting an even more principled standpoint in their insistence on focusing on process rather than content. They maintained that this focus was not merely to do with organisational issues or teachers perceived needs but related to their understanding of the nature of mathematics. As one member of the mathematics group explained, 'Mathematics is not about content but about underlying principles and processes. It is not fundamentally about the names of plane shapes or adding up ... These are just the bits you do to get at what mathematics is.' Similarly, another member of the mathematics group spoke of the need to challenge students' (and teachers) likely misconceptions about mathematics: 'A lot of students come into school with a fixed idea of a topic and how to teach it. I think it's important that students are aware it doesn't have to be like that. Students often have a traditional view of maths, if you say problems they think of story sums, if you say games they think of a board game. They need to be encouraging children to talk about mathematics not there's a right and wrong and that's it.' Further, it was maintained, 'Teachers would want a written lesson telling them how they could safely teach the topic of ... whatever. But maths isn't like that.'
In addition, mathematics specialists claimed that they were concerned that 'spoon feeding' students (and teachers) by prescribing the subject content of tasks, would inhibit them from developing the more profound understandings that could be gained through relating these activities to the particular aspects of content on which they were working. If they gave details of an activity that could be used for the teaching of, for example, number or shape, they maintained students would merely use this activity without thought. One specialist commented, 'We're afraid students will take on our ideas and think 'That's a good idea' - full stop. Whereas if they approach it with a more open mind they will realise what opportunities there are. If they go in with one fixed idea they're closed straight away and will overlook quite a lot.'
The mathematics group therefore, devised activities which required students 'to devise a mathematical trail', for example, or 'to use a mathematical game'. Activities provided structures and guidelines that could be applied by mentors and students to whatever aspects of 'number and algebra', 'shape, space and measures', or 'handling data' were relevant to their school experience - although, again, activities did not focus specifically on the teaching of these strands.
Difficulties with activities
Having drafted their activities, subject groups were satisfied that not only were they adaptable for use with any student, in any context, and with any content, but that they embodied what it was most important for students to understand about the teaching of the subject area. However, difficulties emerged when groups were asked to evaluate the appropriateness and effectiveness of activities outside of their subject specialism. These difficulties were experienced primarily, though not exclusively, in relation to the science and mathematics activities.

While activities had appeared adequately detailed to group members when working as subject specialists, as non-specialists they complained that these activities were 'very vague' or 'too broad'. Difficulties became particularly apparent when teachers attempted to trial activities with students who were working with pupils considerably older or considerably younger than those in the teacher's own class. One group member, for example, commented that as part of his work in science her student had made concrete with the children in his class. She questioned, 'Was it enough for him just to make concrete? What else should he have done? I feel I could have made concrete with my reception children (aged 4-5 years) but I didn't know how to approach it with KS2 children (aged 7-11 years) - how he could have developed it ... taken it on.'

As non-specialists, group members also maintained that they would have preferred a much more structured, didactic approach: they would have preferred to have been told exactly what to do. They stated that rather than 'guidelines' they wanted details of actual activities that students could carry out in the classroom, and activities that they as teachers 'could get something from'. Expecting teachers and students to have to 'reconstruct' an activity in terms of specific aspects of subject content (seen by the mathematics group, as a particular strength of these activities) was considered too demanding and too time-consuming. One group member commented, 'Class teachers need ideas - they'll think, 'I haven't got time to think about this'. 'Another commented, 'When I presented the activities to the student I felt I had to explain what was expected of them and suggest tasks to them because I don't think we can expect them to think of tasks.'

It was also suggested that this approach did not correspond to the way in which student teachers developed their subject-related understandings. As one group members explained, 'They need initial clear guidelines ... do this, make this, attempt this and from that the student learns. They need ... more structure really'. Similarly, another group member commented that it was through modelling the activity to students that she found she was most effective in developing their understandings.

Indeed, the very focus of activities on 'process' rather than 'content' that had been so adamantly upheld by group members when working as
subject specialists, was now brought into question. Where teachers and lecturers lacked knowledge and/or confidence in the subject, they maintained that what they needed to know was how to teach specific aspects of content: For example, one group member, referring to the science activities, commented, 'I prefer more on content - I would have preferred something on each Attainment Target. Where I lack confidence I need more content.'

The fact that these criticisms were focused primarily on the science and mathematics activities may not be surprising given teachers' alleged difficulties with the teaching of these particular subject areas. But it is interesting to consider why criticisms were not levelled at the activities devised by the English and Welsh groups - at least not with such force. Other than the possibility that these activities were more detailed and tightly structured, and that they, in one sense, covered the 'content' of the National Curriculum, it may be that, as one group member commented 'I don't expect teachers to have difficulty with English - it's part of everything'. Further, the comment was made: 'I don't think people feel uptight about teaching language - we can all read and write.' Whether teachers were in fact good teachers of English and Welsh (as a first language) was not the issue - most teachers, it was felt, considered they had some expertise in teaching these subject areas. The significance of teachers' confidence in their subject understandings should not be under-estimated.

Reactions
The criticisms of their activities appeared to be a source of great frustration and disappointment to subject specialists. For example, one subject specialist commented, 'I remember being very disappointed in teachers' reactions to the science activities. There was a terrible sensation of ... where do we go from here? How much more dilution do we need? It couldn't have been more basic.' It was also implied that group members simply didn't make an effort to understand activities within subject areas with which they had difficulty. One group member complained, 'Science? For some people you just say the word and up goes a barrier. And after science comes maths!'. Another reflected, 'There was a lot of disappointment that people weren't using ideas that had been around for years and weren't willing to make even a minimal effort to get into it.' In addition, it was believed that teachers were familiar with the activities that had been devised but understood them in terms of 'child-centred' rather than 'subject-centred' terms. For example, a mathematics specialist explained 'One teacher says she does pattern with her class, but she didn't realise she was doing algebra. You mention the word algebra and symbols come into mind. I think a lot of teachers do things, but are not aware of how they fit into the National Curriculum and to good practice in mathematics.'

The situation arose, therefore, that while group members were complaining bitterly about the lack of detail and guidance given in
activities which were outside of their specialism at the same time they were feeling angry and frustrated about other group members' inability to make sense of the activities they had devised. As one subject specialist later commented, 'C. was very uptight about having to spoonfeed other teachers, yet at the same time she was wanting spoonfeeding in other subject areas. She was reacting to not knowing what a maths trail was ... yet expecting people to know the meaning of the term 'phonemic'!'

Subject specialists and non-specialists
In this project then, the tension was not overtly between the child-centred and subject-centred approaches but between the perspectives of 'subject specialists' and 'non-specialists'. As subject specialists, teachers and lecturers argued that activities designed for subject mentoring should focus on broad approaches to teaching the subject area or key elements of the subject area. They maintained that it is the nature of the subject area and its underlying processes that is of fundamental importance for students to understand if they are to be effective primary teachers. In addition, when working as subject specialists they stated that activities should be open and flexible and involve teachers and students in the 'reconstruction' (or 'transformation') of subject content.

As non-specialists, i.e. when working in subject areas outside their specialism, they argued that activities should focus on how to teach specific aspects of substantive content. They maintained that activities, and how they should be implemented, should be prescribed in detail: there was a desire for 'imitation' of subject content. As non-specialists they also found difficulty in interpreting or reconstructing activity guidelines in terms of actual tasks for students - they were unable to transform the 'theoretical' into the 'practical'. It appeared, therefore, that as 'specialists', teachers and lecturers were able to see beyond the substantive content and beyond their own immediate needs as teachers and mentors to what is important about subject areas. As non-specialists, the content, or rather their lack of knowledge and confidence in understanding and teaching the content may have 'obscured the view'.

And here we have an interesting paradox. On the one hand it appears that a flexible and thorough understanding of a subject area, in particular an understanding of its key ideas, underlying processes and nature, is linked to more open and investigatory teaching methods - indeed the teaching methods that are often associated with the rhetoric of the child-centred ideology. On the other hand lack of subject knowledge (such as that acknowledged by the generalist 'child-centred' teachers in the previous paper) appears to be linked to a focus on substantive content and more closed and didactic teaching methods. It could therefore be argued that primary teachers will only be able to become truly child-centred in their approaches to teaching if they have a thorough understanding of the subjects they are required to teach!
Resolution
Despite the difficulties, subject specialists felt that both organisationally, and at the level of principle, their original decision to focus on 'process', i.e. approaches to teaching the subject area - or in the case of English and Welsh the teaching of key elements of the subject area - was justified. However, it was recognised that, in their original format, activities may not be seen as appropriate and effective by subject mentors - at least when working in curriculum areas where they feel less competent. As one subject specialist commented, 'I think we did get a bit tunnel vision and still are to a certain extent because we know what we are talking about so we assume others should do. But you've got to be aware that teachers need more guidelines, more ideas.' For one mathematics specialist, however, the tension between addressing content and remaining true to her understanding of the nature of mathematics remained. She commented, 'The tension is providing them (teachers) with everything they need so even the weakest teacher could make sense of it and selling out on the principle of the thing.' Ultimately subject specialists elaborated and refined their activities, making them far more detailed and structured; providing examples and illustrations of how they could be contextualised and also providing references to curriculum materials which teachers and students could use for guidance and information. Even so, it was acknowledged that the role of the school's curriculum co-ordinator (or other subject specialist) in helping non-specialist teachers to interpret activities and reconstruct them as practical tasks for their students would be crucial to the effectiveness and success of this work.

Conclusion
Teaching, as I have noted elsewhere (Furlong and Maynard 1995) is rather like a complex three dimensional jigsaw puzzle - it only works when all the pieces are in place. Focusing solely on teachers' knowledge of 'subjects' and considering which of the different domains of this knowledge should form the basis of students' school-based studies, did not prove to be entirely helpful. There were three main reasons why this appeared to be the case. Firstly, teachers' knowledge of subjects is only one element of their practical, professional knowledge. In practice, teachers' subject knowledge can not be separated from, for example, teachers' more general pedagogical knowledge or their knowledge of the context in which they are working. In addition, a consideration of the different domains of teachers' subject knowledge could lead to pedagogical content knowledge being seen as a discrete entity. Understandings about 'how to teach' aspects of subject content could easily become detached from broader considerations of the key ideas, processes and nature of individual subject areas. Without a consideration of these understandings, school-based subject studies could be seen merely as an opportunity for students to amass a stockpile of 'good ideas' for
teaching activities. Although they may not be the initial priority of students (or non-specialist and child-centred teachers) these more fundamental understandings do need to be reflected in any activities designed to support subject mentoring and addressed by students at some point in their training.

Secondly, descriptions of these domains did not appear to accurately characterise the kind of understandings subject specialists wanted their activities to embody. In particular, in his description of pedagogical content knowledge Shulman (1986) seems to be essentially referring to representations of aspects of substantive content. This definition appears to most closely reflect a transmission model of teaching. Unsurprisingly, subject specialists adopted a much broader and more child-centred definition of pedagogical content knowledge than that implied by Shulman: they maintained that activities should 'represent' the nature and underlying approaches associated with the subject area. For example, group members maintained that activities should not be concerned with good ideas for teaching fractions, but rather how to approach the teaching of mathematics.

Finally, the very attempt to make a generalised statement about what 'aspect' of teachers' subject knowledge should form the basis of students' school-based studies may have been inappropriate: students are likely to have different needs within different subject areas. In part, as group members discovered, this is because each subject has its own individual nature, structure, content and demands. In addition, the character and degree of each student's understandings and misunderstandings is likely to vary depending on the particular subject area in which he or she is working.

In this respect, a key insight gained from this project is that any discussion of the content of subject mentoring needs to incorporate a consideration of how student teachers learn. Knowing where students should eventually end up does not specify either the starting point or the route. Previous research indicates that student teachers tend to move from a concern with their own survival as teachers to a concern with pupil learning (Furlong and Maynard 1995, Fuller and Bown 1975) and from the 'practical' to the 'theoretical' - including an understanding of their own personal theories (Maynard 1995). From this project, it appears that in terms of the subject content of their activities students may move from 'imitation' and 'exploration' to 'transformation'. In terms of the activities designed to support subject mentoring this means that student teachers may initially need to model 'ready-made' tasks and importantly, to explore why these are considered appropriate and effective. It is only at a later stage in their teaching experience, and in subject areas within which they feel confident and competent, that students may be able to reconstruct these activities as practical tasks for pupils.

On returning to the original question, 'What aspect of teachers' subject knowledge might form the basis of students' school-based subject studies?' we can see that, in hindsight, the question was actually misleading. There are grave dangers in trying to 'dissect' teachers' practice in this way. A more appropriate starting point may
have been to consider questions such as, 'What do we mean by appropriate and effectively taught activities in each subject area?, 'How can students be helped to develop the knowledge, understandings and skills needed to plan and teach such activities?' and 'What contribution can teachers as subject mentors make to this process?' Although we took a rather long and arduous journey, the final activities devised by group members are intended to address and importantly, to integrate issues of nature, content and child-centred pedagogy. In this way, it is hoped that they will be seen as useful, appropriate and effective by all those involved in initial teacher education.

Postscript
Materials to support schools in subject-based mentoring will be published early in 1996 and disseminated to all higher education institutions and their partner schools in Wales. It is also hoped that these materials will be incorporated into a book by Maynard and Sanders on 'Subject mentoring in the Primary School'.

References


1 The term 'subject specialist' is used as a description of teachers' and lecturers' 'specialist' knowledge and skills in teaching one of the subjects of the core curriculum. It does not imply that the teachers took on the role of specialist as opposed to generalist class teacher in their primary schools.