

TOWARDS A PEDAGOGY OF MATHEMATICS INITIAL TEACHER EDUCATION

Stephanie Prestage & Pat Perks

(School of Education, University of Birmingham)

In this paper we offer a brief discussion of a model created for considering aspects of subject matter knowledge necessary for teaching mathematics where personal subject matter knowledge and professional content knowledge of teachers are mediated by deliberate reflection in order to create a more fluid and connected personal understanding of mathematics needed for the classroom (Prestage & Perks, 1999a and 1999b) . These ideas are further developed to show how they might be used for analysing the pedagogy of teacher educators.

Over the last few years we have been developing a model for discussing aspects of subject knowledge and how this is held by teachers of mathematics. These ideas have recently been made more relevant by the need for Initial Teacher Education (ITE) courses to audit the subject knowledge of students deemed necessary for teaching. The complexity of learning to be a teacher is recognised in all the research related to subject knowledge (Shulman 1986, Wilson et al. 1987, Brown and McIntyre 1993, Aubrey 1997, Banks et al 1999) something that the normalising of ITE into standards and syllabuses and quick entry routes does not reflect. This research reminds us that teaching is not just a body of craft knowledge to be observed and absorbed but that becoming a teacher demands great intellectual effort.

The literature on subject knowledge provided a context and a springboard for our ideas but did not offer a way forward with the analysis of data we had collected from experienced teachers. For this analysis we considered the wider debate on the professional development of teachers. The model described arises mainly as a consequence of the interviews that took place with the expert teachers and from attempts to describe the different ways that teachers talk about subject matter as well as re-analysing data from the research on lesson planning with the pre-service teachers (Perks, 1997, Prestage 1999, Prestage & Perks, 1999a and 1999b). The following quote was crucial to this analysis and the resulting model:

First, certain systems of thought or paradigms dominate a profession's thinking in a way that they are passed unquestioned from one generation to the next The second

problem is the converse of the first. To make practical use of concepts and ideas other than those embedded in well-established professional traditions requires intellectual effort and an encouraging work-context. The meaning of a new idea has to be rediscovered in the practical situation, and the implication for action thought through.

Eraut 1994 p.49

Eraut presents the idea that teachers acquire knowledge through *professional traditions* and in order to accommodate new ideas will need to work on them in the classroom (*practical wisdom*) and then think through the implication of these actions (*deliberate reflection*).

The roots of our model lie in awareness of the beginning stages of professional development with our ITE students who arrive with a certain amount of personal subject knowledge (*learner-knowledge*) that enables them to answer mathematical questions. Graduate mathematician interviewees to our secondary pre-service course naturally hold subject knowledge as learner-knowledge. When asked to calculate the division of one fraction by another, to differentiate a function, to solve a set of equations, all respond correctly. When asked why the answers are correct they do not know. They can do mathematics but they do not necessarily hold 'multiple and fluid conceptions'. Auditing this level of subject knowledge might be necessary but is not sufficient for the developing teacher. The view of teaching for these pre-service teachers is to replicate their learner-knowledge for others to learn. Their subject knowledge is ill-connected and they have to work on this when planning for teaching (Perks & Prestage 1994).

They also bring with them their personal beliefs and certain characteristics of 'being a teacher'. Through the PGCE year they gain different knowledge and understandings of other *professional traditions* - some global like the National Curriculum, the Numeracy Strategy and the examination system with all their attendant exemplar materials, and some local traditions gained from particular school settings such as schemes and textbooks-the ways in which national policies are translated in different settings. Learner-knowledge and professional traditions merge in the first instance to create classroom events for others to engage with learning mathematics.

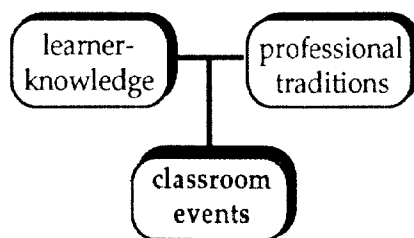


Figure 1

Reflection upon these classroom events, with the integration of learner-knowledge and professional traditions, leads to the beginnings of some practical wisdom that enables the students to adapt activities from the professional traditions to suit their particular circumstances.

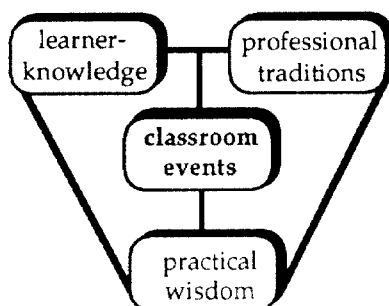


Figure 2

We believe that 'good' teachers reflect upon classroom events at a further stage, i.e. to reconsider their own personal understandings of mathematics, to reflect upon the 'why' not only of teaching but also of mathematics. They come to own a better personal knowledge of mathematics (*teacher-knowledge*, see figure 3) that allows them not only to answer the questions correctly but also helps them to build a variety of connections and routes through that knowledge, that provides answers to 'why' something is so (Prestage, 1999). It is our contention that only when such subject knowledge is informing classroom practice that the real needs of learners and the challenges of mathematics are addressed. The model is completed in the form of a tetrahedron.

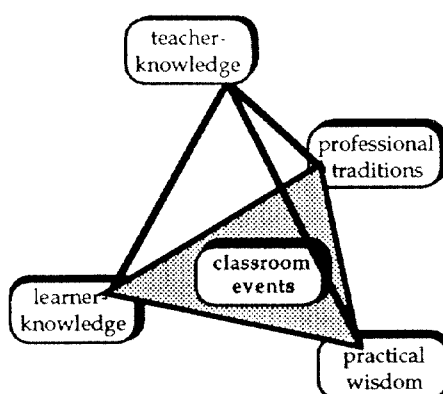


Figure 3

What then are the implications of this for thinking about a pedagogy for teacher education? Is there an equivalent *teacher-knowledge* which informs our practice? We believe that just as teaching mathematics needs fluid and connected knowledge of mathematics (*teacher-knowledge*) so too as

mathematics educators we need an articulated, fluid and connected understanding of teaching mathematics education – the teacher-knowledge of mathematics education.

“I arrived to my current job as a teacher educator with all aspects of the above in place. This was my learner-knowledge for being a teacher educator. I had both learner-knowledge and some teacher-knowledge for mathematics subject matter, I understood the professional traditions and held a certain amount of practical wisdom.”

We will construct a parallel model to the one above but take the mathematical learner-knowledge for a teacher educator as the whole of figure 3.

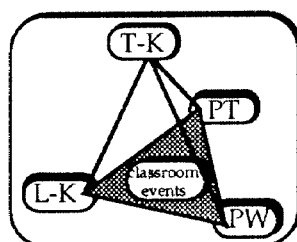


Figure 4: Learner-knowledge for the teacher educator

Imagine this model extended to include not only understanding and knowledge about mathematics but also about the other elements that create the professional teacher, issues related to assessment, class management, equal opportunities.

“I also held a variety of other professional knowledge about general teaching matters. These then formed the basis for me to reflect upon and analyse and synthesise for others to come to know about teaching mathematics.”

The pack of professional ‘teacher-knowledge’ cards might look like this.

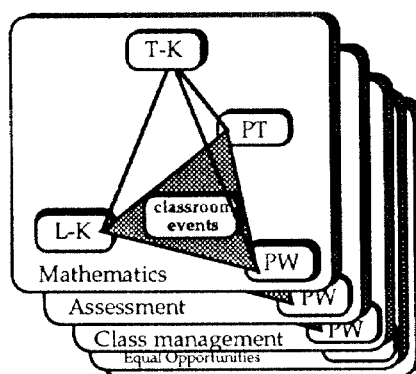


Figure 5: The pack of professional teacher-knowledge cards

And the next level of the model would be:

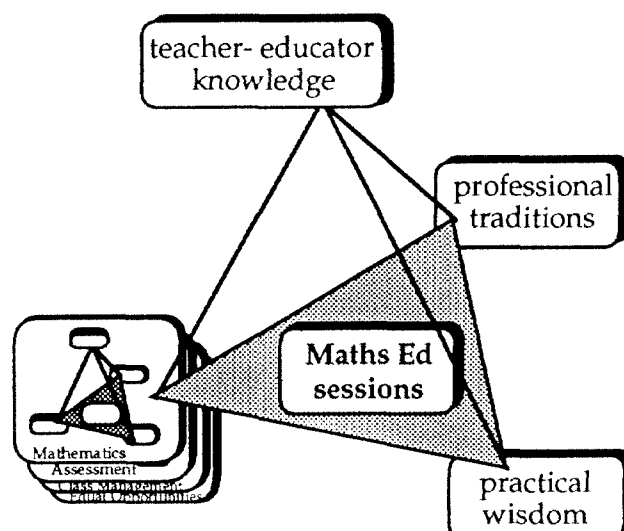


Figure 6:

The professional traditions emerge from personal experiences, education and training, the current government and TTA policies, the mathematics and ICT ITT National Curricula (DfEE, 1998) as well as Ofsted criteria against which judgements are made. Practical wisdom can be defined as considering what the students need to know and how sessions might be constructed for them so that they engage in the ideas.

Discussion from the session in November was wide ranging and we hope to explore the ideas further. One of the questions raised centred around the thorny issue of the theory-practice divide in education. The diagram in Figure 6 offered a strong image not for a theory-practice divide debate but a theory-practice balance analysis of the knowledge held by those involved in ITE where the balance of practical wisdom, professional traditions and learner-knowledge might be weighted different for each of the cards. This has set us upon a whole new road of data collection and analysis.

References

- Aubrey, C (1997) *Mathematics Teaching in the Early Years: An investigation into teachers' subject knowledge*. London: Falmer Press.
- Banks, F, Leach J & Moon B (1999) New Understandings of teachers' Pedagogic Knowledge in Leach J & Moon B (eds) *Learners and Pedagogy*, London: PCP
- Bassey, M (1995) *Creating education through research*. England: Kirklington Moor Press (in conjunction with BERA).
- Brown, S and McIntyre, D (1993) *Making sense of teaching* Buckingham: Open University Press.
- Buchmann, M (1984) The priority of knowledge and understanding in teaching in Katz L and Roth J (Eds) *Advances in teacher Education* (Vol 1) NJ: Ablex, pp.29-50.

- Perks, P. & Prestage, S. (1994) Planning for learning, Jaworski, B & Watson, A (eds) *Mentoring in Mathematics Teaching*, London: Falmer Press.
- Perks, P.A. (1997) *Lesson Planning In Mathematics: a Study of PGCE Students*, unpublished Ph.D. Thesis, University of Birmingham.
- Prestage, S. (1999) *An Exploration into Teachers' Subject Knowledge*, unpublished Ph.D. thesis, University of London.
- Prestage, S. & Perks, P., (1999a), Subject matter knowledge in experienced and novice teachers of mathematics, *Paper presented at the annual conference of BERA*, Brighton: University of Sussex, <http://leeds.ac.uk/educol>
- Prestage S & Perks P (1999b) Questions about subject knowledge: learner-knowledge and teacher-knowledge in Bills E (ed) *Proceedings from the 4th British Congress of Mathematics Education July 1999* University College of Northampton, <http://www.eduweb/>
- Shulman, LS (1986) Those who understand: Knowledge growth in teaching, *Educational Researcher*, Vol. 15, No. 2, pp. 4-14.
- Wilson, SM. Shulman, LS and Richert, AE (1987) '150 Different Ways' of Knowing: Representations of Knowledge in Teaching in Calderhead J (1987) *Exploring Teacher's Thinking*. London: Cassell Education.