Jane McNicholl & Ann Childs

University of Oxford

Learning science to teach science: the role of school subject departments in ITE

Paper presented at the Sociocultural Perspectives on Teacher Education and Development' conference, University of Oxford, 7 – 8 April, 2008

The focus

This paper draws on research concerned with student-teachers' learning of subject specific pedagogical knowledge (SSPK), conducted within an established initial teacher education (ITE) partnership, the Oxford Internship Scheme. The specific context is relevant insofar as this particular course is premised on clear principles about the distinctive and complementary contributions that university and school-based teacher educators have to make to beginning teachers' learning. University tutors, because of the nature of their role and the context within which they work, provide 'academic' or propositional knowledge about effective teaching practices (1), whereas school-based teacher educators offer, precisely because of their work as practising teachers, is an insight into their 'professional craft knowledge' (2) the complex, usually tacit, knowledge that informs and is embedded in the sophisticated, everyday practice of teachers.

Within this model of partnership the notion of SSPK is seen very much as a specific form of teachers' practical or craft knowledge, although many of the components on which it may draw can obviously be explored and examined within the university. Whatever theoretical model of such knowledge one subscribes to (3), there seems to be widespread agreement that such professional knowledge is only created in practice and 'teachers' pedagogical constructions' result from the 'inventive processes' of planning and teaching (4); making schools a crucial site for student-teachers' learning of SSPK.

Within science ITE here in the UK, concerns to do with student-teachers' development of SSPK arise due to the current expectation that qualified teachers should be sufficiently familiar with scientific content in order to teach all three sciences at least up to the age of 14 when a significant proportion of those beginning postgraduate teacher education programmes possess an academic qualification just one level above this (5, 6, 7, 8). Neither is this just a concern for the UK, elsewhere in the world, science teachers can spend considerable time teaching outside of their subject specialism (9, 10). Aware not only of the time constraints on seeking to develop subject or domain knowledge within the university context, but also of the limited impact that any such direct subject knowledge teaching can have within an ITE course (11), the aim of the project was to explore the potential for subject specific professional learning that lay within school. Our previous research (12) had suggested that considerable workplace learning of subject knowledge and SSPK took place within science departments.

The Research

Informal learning in the workplace is increasingly being seen as constituting one of the most important ways of learning at work (13, 14 15, 16). Given the infancy of this interest, there are few theoretical and empirical frameworks to use to investigate workplace learning (17). However, what seems to be crucial at this time, and what this study aimed to do, was to help conceptualise the organisational and contextual factors that facilitate or constrain informal learning in an ITE programme. The first stage involved conducting a short trial of a methodology intended to capture the complex interactions that occur during such informal workplace learning. This exploratory project

focused on two effective teaching, learning and mentoring school science departments within our ITE partnership. Two researchers, as participant observers, spent ten days in each science department. Teachers were interviewed, student-teachers shadowed, break times observed, and department meetings as well as any subject specific in-service training attended. Field notes from the observations were used primarily to record and capture what happened and what was said and these were written up contemporaneously or as soon afterwards as was possible. Later a running commentary was added to these notes to clarify them and add a level of interpretation from the observer's perspective. Analysis of the interviews at this first stage has been largely descriptive in nature, drawing on both the accounts in our field notes of what went on in the departments' team rooms where teachers met and talked and on the interview data.

Findings and discussion

The extract below records one example, amongst a number, of a key instance of the 'learning' of SSPK that were observed and reported. This conversation took place in the team room between James, a student-teacher with a PhD in physics and Rachel, a newly qualified (NQT) physics specialist teacher, who like so many entering the profession, has an applied rather than a pure physics degree.

Rachel (NQT) is working on her laptop in the team room and James (student-teacher) is planning lessons. Rachel asks James about good ideas about how he would explain to students in Y10 that objects fall at the same rate despite their being different masses. James begins by writing F=ma in the top right hand corner of the notice board and then

other equations down the whiteboard. Susie (student-teacher) is listening. Rachel then says she needs a simpler explanation. Hazel (Head of Department and experienced physics teacher) enters the team room and says that this is difficult and gives Rachel an analogy where she uses Canderel and then biscuits. Susie says she gets it. However, Rachel says that's all very well, but she is thinking about the students in her Y10 class and they won't get this analogy. Hazel gives another explanation and Rachel seems to reflect on this and then Hazel leaves.

[observation notes school B, 11.6.06]

James seemed to be sharing his 'high level' subject knowledge, when Hazel came in and offered some ideas about how to teach this topic in the form of particular analogies, which we would characterise as SSPK. Both student James and experienced Hazel were able to help the NQT, Rachel, develop her SSPK for this difficult scientific concept but it is only through her deeply contextualised reflections on the peculiarities of a particular class that Rachel felt satisfied with the help on offer and was able to think about SSPK for this one context. This could also perhaps be characterised as an example of the development of pedagogical context knowledge (18) and is similar to the learning described by Hodkinson and Hodkinson (19) as 'unplanned and serendipitous and does not have preset objectives or easily identifiable outcomes' (p. 122). Further, it seems evident that in addition to Rachel, there are other learners in this scenario: Susie, a biology specialist, has learned both physics subject knowledge and SSPK and James has learned about transforming his high level subject knowledge for teaching. In his interview, James talks about this incident and questions the capacity of observing

teachers alone to provide such insights since this often does not reveal how the teacher has arrived at what they were doing:

…… otherwise you can copy things that teachers do without understanding why and then they don't quite fit.

[James, interview]

A crucially important feature of both science departments were the team rooms that were used extensively by all staff; this allegiance to the departmental team room very much epitomised Hargreaves's (20) 'Balkanisation'. From the preliminary analysis of the observational and interview data, it became quite apparent that both of these physical spaces within the two science departments studied provided opportunities for student and more experienced teachers to learn subject knowledge for teaching science and that often they would take advantage of these opportunities. In addition to a shared space to sit, relax and communicate with others, the team rooms had specific features that seemed to facilitate the communication and learning between teachers, these including, notice boards and central tables for communicating and sharing teaching ideas and resources.

However, it is not simply the provision of the physical space that afforded our teachers rich opportunities for learning. As longstanding partners in Internship, both departments have a real commitment to working with and supporting beginning teachers. Further, within both departments there appeared to be an ethos characterised by trust and mutual respect, where doubts are shared without fear of feeling like a failure. Thus, in terms of

seeking help with knowledge for teaching science, there was an openness to request and offer support. Additionally, all members including student-teachers, were seen as legitimate sources of different kinds of knowledge (19) and there was recognition that this knowledge held by members of widely differing levels of experience ought to be distributed and shared and debated.

It's quite an honest place where people will come in and say 'I am not quite sure how to teach this topic'. Particularly if you are teaching outside your subject specialism people are really good at giving support.'

[HI teacher and mentor for NQTs]

This study has revealed that rich opportunities for science teachers to observe, engage and learn collaboratively exist within subject departments which have a strong geographical location in a team room, and the confidence necessary among staff to admit problems and seek advice. For the future, the important questions that science teacher educators around the world might want to ask are: i) how we can work most effectively with subject departments to enable student-teachers to learn from (and contribute to) the distributed forms of knowledge there and ii) how is student-teachers' learning affected when the affordances identified are not in place?

References

1. McIntyre, D. (1991) The Oxford University model of teacher education, *South Pacific Journal of Teacher Education* 19 (2).117-129.

2. Brown S. & McIntyre, D. (1993) *Making Sense of Teaching* (Buckingham, Open University Press).

3. Van Driel, J. H., Verloop, N., & De Vos, W. (1998). Developing science teachers' pedagogical content knowledge. *Journal of Research in Science Teaching, 35*(6), 673-695.

4. Hashweh, M.Z. (2005) Teacher pedagogical constructions: a reconfiguration of pedagogical content knowledge *Teachers and Teaching: theory and practice* 11(3), 273-292.

5. Harrison, J. & Pritchard, J. (1993) The demands on newly-trained teachers of science at Key Stage 4, *Education in Science*, 151, pp. 9-11.

6. Dennick, R. & Joyes, G. (1994) New science teachers' subject knowledge, *School Science Review*, 76(275), pp. 103-109.

7. Institute of Physics (2002) *Physics Teacher Supply*. A report of the Institute of Physics.

8. Staff 'crisis' threatens physics (2005) Available online at http://news.bbc.co.uk/2/hi/uk_news/education/4450208.stm (accessed December 20th 2005).

9. The Washington Times (2003, July 16) Federal Education report finds shortage of qualified teachers. Available online at : http://www.washtimes.com/ national/ 20030715-114915-3853r.htm (accessed 14 January 2007).

10. Organisation for Economic Co-operation and Development (2003) *Education at a glance* (Paris, OECD publishing).

11. Preece, P. F. W., Postlethwaite, K. C., Skinner, N. C. and Simpson, K. A. (2004) Investigating the 'failure of further learning' effects in preservice science teacher education. *International Journal of Science Education* 26 (7), 805- 819.

12. Childs, A. & McNicholl J. (2007) Science teachers teaching outside of subject specialism: challenges, strategies adopted and implications for initial teacher education, *Teacher Development* 11, 1, 1-20.

13. Boud, D. and Garrick, J. (1999) Understanding Learning at Work (Routledge: London).

14. Eraut, M. (2000) Non-formal learning and tacit knowledge in professional work, *British Journal of Educational Psychology*, 70, 113-136.

15. Organisation for Economic Co-operation and Development (2003) *Beyond rhetoric: Adult learning policies and practices* (Paris, OECD publishing).

16. Williams, A., Prestage, S. & Bedward, J. (2001) Individualism to collaboration: the significance of teacher culture of newly qualified teachers, *Journal of Education for Teaching*, 27(3), pp. 253-267.

17. Skule, S. (2004) Learning conditions at work: a framework to understand and assess informal learning in the workplace. *International Journal of Training and Development* 8, 1, 8-20.

18. Barnett, J. & Hodson, D. (2001) Pedagogical Context Knowledge: Towards a Fuller Understanding of What Good Science teachers Know, *Science Teacher Education*, 85 (4), 426-453.

19. Hodkinson, H. and Hodkinson, P. (2005) Improving school teachers' workplace learning, *Research Papers in Education*, 20 (2), 109-131.

20. Hargreaves, A. (1992) Cultures of teaching: A Focus for Change, in M. Fullan & A. Hargreaves (Eds) *Understanding Teacher Development* (New York, Teachers College Press).