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Think piece

What are we
learning about...?

'Making mathematics count' in school networks

Learning with insiders: complex professional development

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Networked Learning Communities

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Learning with insiders: complex professional development

This think piece explores the rationale for the continuing professional development of teachers of mathematics. It examines the case for the ongoing development of teachers' professional learning within a networked context and argues that if learning and change are to be valued, then they need to begin *inside* the world of practitioners. By drawing upon illustrative examples of professional development in action within learning communities, we are given an insight into how the processes of collaborative learning and enquiry can provide a powerful medium for improving and developing the classroom practices of mathematics teachers.

Given that the most interesting and relevant model of professional development involves teachers working together for some shared purpose, this short paper explores the ways in which personal and pedagogic subject knowledge can be included and developed in their work. It concludes by suggesting that mathematics learning networks provide a potentially valuable counterpoint to top-down models of change, whereby teachers are given opportunities for professional learning and development from the inside out, rather than the outside in. □

Learning with insiders: complex professional development

" I know my teaching is now the same old boring stuff and I get by on classroom management. I expect PGCE novice teachers to do something more exciting. "

I overheard this remark when visiting an unfamiliar school and, from the point of view of someone involved in the development of new teachers, it made me slightly angry. Why should student teachers experiment if the teachers from whom they are learning do not? On reflection, however, the remark made more sense when I thought about the everyday lives of mathematics teachers: the rush to get through the curriculum, the testing regime and the expectations always to be doing more of this and more of that. It is hardly surprising for a teacher to feel that she is stuck in habits of teaching which are less than thrilling, it is hardly surprising that learners react against it. What is most surprising about this teacher is that she recognises a need for something different, but looks to others to provide it. The provision of materials, guidance and in-service sessions, the availability of various systems for schools and teachers to disseminate good practice, the copious ideas on the internet – none of this reaches into her classroom and her teaching.

Learning to teach

In the early days of teaching there is a structure within which we learn. Firstly, we have to pass a teacher training course by showing that we can operate in the complex world of classrooms and get some students to learn maths. We have to fit into the schools where we are placed, their habits and practices, their ways of doing things. We know that there are things we do not know, and go out of our way to try to learn them. Sometimes during training we have to push at the edges of the school's normal practice in order to pass the course, so find ourselves experimenting without any models on which to draw. We may have to teach a lesson using practical materials, or approach a core topic investigationally, or use ICT to generate a whole-class discussion with only our course tutor's out-of-date experience and fellow novice teachers to rely on for help. But the minimum spur to experiment is the desire to get a qualification, and we make it work by enhancing this with our excitement at becoming teachers.

Continuing learning

When we enter our early years of teaching, the pressures of training courses are no longer there. Whatever sort of department we work in, we begin to fit into their ways of doing things, their ways of dealing with outside demands, seeing these either as unwelcome intrusions or useful structures, as the rules for behaviour are relatively peripheral to what we actually achieve. We attain a kind of equilibrium which maintains our normal practice in spite of external changes imposed upon us.

In a recent survey about future demand for professional development courses, schools' responses were very revealing. Some schools thought that such courses were supposed to be remedial for teachers in difficulties, some thought courses were irrelevant because all their teachers were experienced, some thought that such courses provide a place for teachers to reflect on practice and think about ways forward. One school wanted a significant number of maths teachers to take a professional development course as a group. The notion that teachers can continue to learn and change, and that this can be an integral part of professional life, is delicate. To impose requirements for learning on teachers who see courses as only for weaker colleagues causes resentment, as might visits from 'expert' teachers. At the other extreme, a collegial group attending a course together forms a nexus for development in a department which energises others.

Demonstration lessons by advanced skills teachers, one-off inset sessions and big boxes of National Strategy guidance are seen by many to be *outsiders* to the daily lives of teachers, who may not see any need for change or cannot find any room for change. Furthermore, teachers may not share the underlying beliefs and knowledge which led to the creation of such resources, so that putting them directly into practice might have very different outcomes from those intended.

Effects of imposed change

An advisory teacher had been urging teachers to develop whole-class discussion using learners' own methods as the starting point. He provided a model lesson starter which invited methods for calculating ratios of given amounts. A teacher who believed that she should guide learners towards correct methods curtailed classroom discussion of an incorrect method, substituting her own with the words: "This is the method which always works, always gives you the right answer." In contrast, another teacher

Pause for thought...?

How can teachers' interest in learning be enhanced in professional development and become the central force for improving?

who believed that discussion was the best way to sort out differences and meanings let learners explore an incorrect method, asking for justifications of the way it worked and the answers it gave. By the end of the lesson, nothing was resolved, but learners knew that it was wrong and left the room still arguing about why it was wrong. In a third class, learners compared different methods in a very noisy argument and decided which ones were most useful in most cases, checking that the answers made sense, and declared them to be the '8B3 toolbox methods'.

These teachers had each held a whole-class discussion based on learners' own methods but the students' learning had been totally different. In one case, discussion had been to reveal what was wrong so that the teacher could cure it. In the second, mathematics was treated as an arena for extended debate which might take time to resolve. In the third, mathematics was about creating agreed norms and standards. All these teachers believed in what they were doing. All were working within habitual, normal practices. All believed, however, that they had changed the way they taught. The influence of day-to-day colleagues, atmosphere, habits, beliefs and systems dominates everything. If we work in environments in which everyone is comfortable with the learners' attainment and the ways in which teachers achieve this, what more is there to learn?

These three quotations reveal contrasting views about expertise, that it means making no changes, constant changes or considered changes:

" I have been teaching further maths for 20 years, most of that time from the same lecture notes so they must be pretty good. "

" I never keep notes and plans from one year to the next. Every group is different and I am always trying new things. "

" I honed this lesson over five or six years with various groups, trying different examples and sequences of tasks until I could be fairly sure it would work. "

Clearly change for its own sake is not an appropriate or sufficient expectation for fluent practitioners. While imposed change or imposed professional development courses offer ideas for development for some teachers, they depend on working conditions which support and value learning and change. If learning and change are to be valued, then they need to begin *inside* the world of practitioners. For adults in full-time employment, real and lasting development comes from inside, with the support of *insiders*.

Willingness to learn

There are two fundamentally different ways in which people relate learning to the way they see themselves. Either we see learning as accumulating expertise in knowledge and skills, gradually piling new knowledge on top of old knowledge until we feel we have enough, or we can see it as a continual development of our capacity to learn. For teachers, the first approach is not very helpful because at the worst extreme one can do all the things which one is expected to do, but without the underlying qualities which come from understanding maths, understanding learners and caring about both. It is easy to imagine someone who, having taught for a few years, then claims to have nothing left to learn. This view is even encouraged by the lists of standards for Qualified Teacher Status and the absence of professional development expectations for teachers in the UK.

Teaching attracts people who are interested in learning at a variety of levels: for themselves, for others, for economic advancement, for social inclusion. (They tend to value learning for its own sake.) It is typical to find people attracted to the profession because they see learning as part of becoming a person and want to help youngsters in that process. How can this interest in learning be enhanced in professional development and become the central force for improving teaching? ☐

Examples of learning communities

I offer two examples of projects which have been shown to lead to significant change, and draw out from them some key features which are replicable.

Lesson study

The first example is from Japan, where lesson study is an accepted feature of teachers' lives[1]. Primary mathematics teachers pursued a three-year study which started when their school developed an action plan. The department selected one aspect of the plan, 'student happiness', as a focus for studying their own practice, and a sub-group of teachers proceeded to discuss features of a lesson which might address this aspect through the normal mathematics curriculum. The topic chosen was subtraction across 10. One teacher (the least experienced, as it happened) chose to teach this in front of colleagues, and there was a long discussion afterwards sharing alternative interpretations and ideas about how the lesson could be improved. These meetings went on so long, voluntarily, that the headteacher put a curfew on them, insisting that they should end by 6pm.

Gradually, a new version of the lesson was prepared and another teacher volunteered to teach it in front of the whole department and an invited mathematics educator from a local Higher Education Institution (HEI). Further discussion of a very detailed kind took place. Colleagues discussed the choice of examples, the modes of presentation, what the teacher actually said, the relationship between the questions used in class and those for homework. The level of detail included consideration of whether 12-7 required different understanding from 12-5. They discussed the points that learners would have found difficult, the role of the manipulatives produced for the lesson and how they were used, the way the teacher responded to different learners' ideas and so on. The HEI educator provided input about research, learning theories, practices elsewhere and overarching principles. The process was one of detailed analysis of every part of the lesson and synthesis towards a new version. Finally, a third version was taught, to which teachers from many schools were invited as observers. More discussion followed and the entire three-year project ended with food and saki, and congratulations all round.

Improving Attainment in Mathematics Project

The second example is the Improving Attainment in Mathematics Project (IAMP), which identifies aspects of good practice for learners whose levels of attainment in early secondary school are below national expectations[2]. Ten teachers were recruited who were committed to making a difference and who believed that their students could learn mathematics in sophisticated ways, given opportunities, encouragement and high expectations. This was in reaction to the prevailing philosophy of 'catching-up' through mechanistic methods and testing. The teachers were visited and observed in schools and met regularly as a group to discuss methods and share beliefs. Often these discussions would centre on teacher presentations and the ongoing analysis of practice by the research team. Teachers were also given sources of ideas by the research team[3] but not told what to do, apart from to focus on the development of mathematical thinking.

Each teacher had a slightly different view of what this meant, so that within the group there was a variety of ways to teach. Nevertheless, each teacher was committed to making a difference, and they learnt from each other. Without any overt expectations that they should change in particular ways, all teachers reported that they knew they were giving more time to learners to think things through by extending the waiting time for answers, by extending discussion time and by setting longer, more open-ended situations in which to explore concepts. It was also found that all teachers espoused similar principles but enacted them in very different ways. At the end of the project a booklet was published summarising their practices, and this was disseminated and taken up widely by groups of teachers, Local Authorities and HEIs.

[1] I have adapted and summarised this example from Fernandez, C & Yoshida, M, 2004, *Lesson study: A Japanese approach to improving mathematics teaching and learning*,. Mahwah, N J, Lawrence Erlbaum Associates, Publishers

[2] This project was supported by two grants from the Esmee Fairbairn Foundation: 01-1415, 02-1424. A booklet describing the outcomes of this study is available at www.atm.org.uk as a download associated with journal MT187

[3] They were given copies of: Watson, A & Mason, J, 1998, *Questions and Prompts for Mathematical Thinking* and Ollerton, M, 2002, *Learning and Teaching Mathematics Without a Textbook*. These are both published by Association of Teachers of Mathematics, Derby. Also Prestage, S & Perks, P, 2001, *Adapting and Extending Secondary Mathematics Activities: new tasks for old*, London, David Fulton

Pause for thought...?

How might you go about seeking out opportunities for networked professional development in your context?

Examples of learning communities

Both of these examples depend on a focus which is interpreted by teachers, providing a sense of being in something bigger than themselves while respecting and using their professional knowledge. In both cases, the starting point was existing teaching expertise, and this was shared with a community which developed its own learning culture. Input from HEI was advisory in each case and did not tell anyone how to teach. The HEI provided research knowledge, knowledge about learning, knowledge about sources of ideas and an overarching viewpoint. In the second case this included the systematic collection of data and other information for dissemination. In both cases, there was a group structure with a timetable within which to work so that people were responsible to each other as well as to their institutions and outsiders. In each case there was dissemination of shared practice to others of various kinds – in organised demonstration, seminars or publication. In neither case was anyone forced to change. Indeed, in the second project we started by talking about change but eventually one teacher objected and said, "I haven't changed anything." For her, taking a problem-solving approach which included the frequent introduction and evaluation of new ideas was normal practice. A further feature of these examples is that they have both made an impact well beyond the teachers concerned.

To summarise, in both cases teachers:

- focused on improving their learners' experience
- participated voluntarily
- used their own interpretation of a focus
- started with their own expertise
- felt a sense of belonging to something important and purposeful
- had institutional support
- worked in a team, sharing responsibility
- developed a plan, structure and timetable
- used knowledgeable input and a reflective overview from HEI
- respected ideas from all sources
- disseminated their work to other teachers

These projects exemplify professional development which is meaningful and interesting for teachers. It is based soundly in practice translating into, and emanating from, lessons immediately. It is respectful in that it recognises practitioners' knowledge. The focus is on learners' experience, not teachers' learning or teacher change. It eschews a deficit model of teaching and teachers. Teachers' ideas are both the raw material for knowledge and the outcome of the knowledge-creation process. For some teachers in the IAMP project, the main effect was that they became more articulate about what they did and why they did it, and this language allowed them to apply their own ideas more systematically and imaginatively, and to adopt others' ideas. Theoretical input is only valuable insofar as it informs practice, theory for dissemination is only valuable insofar as it arises from, and gives language to, practice.

All this is fine if you happen to be in a department which gives time to this kind of developmental work or are pursuing a distance-learning professional development course which encourages research into your own practice. But these routes can be lonely at times, and participants can become trapped within a limited discourse. For example, if your department focuses on achieving the exam results predicted by one of the familiar statistical packages, you may work towards these successfully and feel that you have done a fine job. Within your own group, however, you may never hear of teachers who are doing significantly better than this. How would you ever hear about the teacher whose mathematics set completely overtook the one which was seen to be above it after two terms of her teaching, or the whole school in which the typical student who enters the school at level 3 achieves level 6 in the Key Stage 3 SATs?

If you model your development on doing what you already do, but doing it better or more often, such radical differences may be beyond your reach. The input from others who have more of an overview, whose job includes keeping up to date with literature, going to conferences, observing a wide range of teaching and so on, is a central feature of radical change. Actively seeking new possibilities is hard to do on your own or within one department, and passive waiting for someone to tell you about them is obviously not a sensible option. HEI educators are one source of such knowledge, along with the Association of Teachers of Mathematics and the Mathematics Association. Internet use and emailing lists are yet more sources. □

Developing subject knowledge

Pause for thought...?

What kind of teaching culture would encourage teachers to explore ideas themselves before teaching them?

So far I have described ways in which teachers can work on *how* they teach, so that their teaching is more effective and results in better learning for their students according to their own measures. But how can teachers develop *what* they teach? My own knowledge of teaching has grown in three main ways: watching other teachers, reading about teaching, and doing mathematics. From the last of these I maintain a sense of what it is like to learn and what it is like to play with mathematics. When I was a school teacher this profoundly influenced my practice, and now I am a teacher educator it still does so. I have had the privilege of observing many teachers and learning from them about the 'how' of teaching. I have also had the disturbing feeling that not all teachers explore mathematics for themselves and this limits what they teach. Here are some examples of what I mean.

Observing the teaching of BODMAS, or BIDMAS, I have never seen anyone give examples for which these mnemonics fail to work or do not give enough help. For example, when calculating 3-5+2, if we do the addition before the subtraction we get a wrong answer. In what circumstances would we have to do the addition before the subtraction as BODMAS suggests? Further, given something like (2+3)-(2+3) in a clinical interview, a student asked, "I know I have to do the brackets first, but which bracket should I do first?" Typically, textbooks do not give examples like these in BODMAS exercises, so it is up to teachers to introduce them or to find another way for learners to decide how to approach calculations. How do teachers learn about these problems and develop ways to address them if they do not do so in their initial training?

A teacher offered some practice exercises for learners to turn fractions into decimals. The first few were terminating and the later ones were not, so she asked them to give the answers to three decimal places. The last part of the exercise involved ninths, elevenths and sevenths. Most of the class were working these out themselves by doing the divisions with pencil and paper methods, so there were some exclamations of interest and realisation about the fact of the recurrence and the reasons for it. I was puzzled about rounding sevenths to three decimal places, since so much can be learnt by continuing the division for much further and comparing the results of calculating ½, ⅐, ⅓ and so on. If you have never done this for yourself I can recommend trying it. You will find it is a superb 'selling point' for doing division. What disturbed me here was that the teacher had clearly not done this for herself either. She had not explored what it might be like to do these divisions, what learners might notice while they were doing it and what might arouse their interest. What kinds of teaching culture would make it more likely that a teacher would explore ideas herself before teaching them?

Another example is the use of textbooks which try to make complicated things sound simple. For example, if a teacher unthinkingly uses a definition of proportion as 'part-to-whole' because that is how it is given in some books, then how are learners to relate this to 'direct proportion' later on, or to explaining how shapes can be 'in proportion', which have little to do with 'part-to-whole'? How can teams of teachers work critically with new textbooks in ways which reveal these issues?

I am not for one moment suggesting that the teachers whose practice led to these observations should not be teaching mathematics. Rather, I am suggesting that the way knowledge is transformed into tasks and the way knowledge is used in all aspects of teaching needs constant review if teaching is to improve. Given that the most interesting and relevant model of professional development involves teachers working together for some shared purpose, can personal and pedagogic subject knowledge be included in their work? □

End piece

I have argued that the most effective development occurs when teachers choose to work on their practice in some kind of supportive group involved in a shared project. But isolation can limit possibilities, and without knowledge of other ways of teaching and imagined outcomes, departments and teachers may end up only doing more of what they were already doing, rather than changing the landscape of achievement. Fluency may improve, but no new knowledge and new understandings get created. Learners may remember BODMAS better but still get stuck about when and how to use it. The curriculum may be covered but learners still not understand ratio. More learners may get grade C and above but still not choose to study maths after 16.

The role of HEI in the project examples described earlier was, at the very least, to provide input about other possibilities. In the second example, where there was not an existing culture of working together across schools, it was the HEI who initiated the project and brought people together. In both cases, the insiders together created knowledge about *what* and *how* – practical knowledge in which theory and practice co-exist as strands of a braid. The outsiders provided vision from beyond everyday concerns and knowledge from the outside world. They could see what was happening as particular examples of more general developments. They also recorded the development of practical knowledge in ways which could be disseminated as more general principles and knowledge about *why* and *when* and *what else*. In the first example, the initiator was the school; in the second, it was the HEI. It could be a Local Authority or a group of schools which start the process.

In some mathematics departments, the discussion is about what is taught to whom. In others, discussion is about what is taught to whom and how. In some departments, teachers share mathematical ideas so that all teaching is centred in a culture of mathematical exploration. In yet others, people talk about what, whom, how and why and constantly reach beyond to see what else is possible. Growth towards the latter kind of enriched learning environment can start anywhere and can then develop organically. A model might be: HEI shows what is possible by providing visionary input, by raising discussion within existing partnerships or by seeking partners in change initiatives. Schools seek help in working on some area of development. Schools use existing outside provision or promote the development of other provision. HEI finds schools making changes and joins them to observe and record what happens, drawing other schools into this process. All kinds of relationships and growth are possible.

Ideally, mathematics teaching as a profession would become an enriched learning environment in which teachers felt themselves to be part of a vibrant learning community drawing regularly, with colleagues, upon Local Authorities, HEIs and professional associations to both contact and create new knowledge about mathematics teaching.

My personal dream is that such growth will also include a shift of focus. The top-down model of change which has dominated for the last few years has promulgated the view that mathematics is something we do to students using boxes, textbooks and interactive whiteboards as the tools. If, instead, the profession took the view that mathematics is something we do for ourselves and with students so that it becomes something they do for themselves, then classrooms and mathematics departments could also become mathematics exploration communities within mathematics learning networks. □

Pause for thought...

Use this page to make notes and record your thoughts.

Pause for thought...?

1

***1** How can teachers' interest in learning be enhanced in professional development and become the central force for improving teaching?*

2

***2** How might you go about seeking out opportunities for networked professional development in your context?*

3

***3** What kind of teaching culture would encourage teachers to explore ideas themselves before teaching them?*

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