Professional Experience in Learning to Teach Secondary Mathematics: Incorporating Pre-service Teachers into a Community of Practice

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Wenger (1998) and Lave and Wenger (1991) developed a social theory of cognition in which learning takes place as a result of one's *legitimate peripheral participation* in a *community of practice*. In this paper, we apply Lave and Wenger's theory in learning to teach secondary mathematics. We report on clinical interview data concerning the practicum experiences of eight students enrolled in the Graduate Diploma in Education programs at two universities. Factors which influence the pre-service teachers' classroom practice include the pedagogy of the supervising teacher, the academic ability of pupils, and concerns about classroom management.

One of the most significant rites of passage in learning to teach secondary mathematics is the period of school-based professional experience known as the practicum. The practicum is completed under the supervision of a more experienced teacher who is charged with the task of assisting the pre-service teacher develop confidence and expertise in the art of teaching. The practicum is also designed, notionally at least, as an opportunity for novice teachers to experience first-hand the convergence of the theory discussed in their university methods course with the daily practice of the classroom. However, the practicum is far more idiosyncratic in nature than that, and the degree to which these goals are achieved rests almost exclusively with the individual cooperating teacher, who is more likely to see his or her role as one of inculcating the pre-service teacher into the traditional norms of the status quo (Jaworski & Gellert, 2003).

This paper reports on the most recent stage of a project in which we have followed a group of Graduate Diploma of Education (Grad Dip) students in two universities and investigated the pre-service secondary teachers' beliefs about mathematics and mathematics teaching as they progress through their university studies (see Prescott & Cavanagh, 2006 for a report of our earlier work). Here we focus on the pre-service teachers' experience of their practicum and how they intend to teach as they begin their first year of employment in a school.

Learning as Participation in a Community of Practice

Much of what an individual learns about teaching from his or her practicum experience is gained through interactions with others in various communities and so the contexts of these communities are crucial in determining the nature and extent of what is learned (Cooney, Shealy, & Arvold, 1998). In recent years, the work of Lave and Wenger (1991) has proved helpful to researchers in understanding how pre-service teachers come to know and learn about the practice of teaching. For Lave and Wenger, learning is a social activity that is derived from active engagement in the world in a *community of practice.* Such communities are characterised by mutual engagement in valued enterprises that are defined by the participants through a shared repertoire and that hold the community together. Thus the community of practice is by no means a homogeneous grouping since it includes both

veterans, who are fully absorbed into the culture of the community, and novices, who are just beginning to gain greater participation in the community and become more knowledgeable about its shared history.

There are four key components in Lave and Wenger's social and situated view of learning. They are: *meaning*, which is a way of discussing how we experience the world as relevant and meaningful; *practice,* a way of talking about the shared social, cultural and historical perspectives that sustain mutual engagement; *community,* which is the unit of organisation in which the joint enterprise is recognised and defined; and *identity,* which describes the role of learning in changing who we are and how we define ourselves. In particular, Wenger (1998) characterises three modes of belonging and sources of identity formation: *engagement* or mutual participation in joint tasks; *imagination,* a willingness to explore and try new things, and then reflect on how these relate with other practices; and *alignment,* which is concerned with the convergence of a common focus, cause, or interest.

Lave and Wenger (1991) describe the position of neophytes within the community of practice as *legitimate peripheral participation*, by which they explain both the developing identity of participants in the community of practice and the very formation of these communities in the world. The newcomers' legitimate peripheral participation provides them with more than a vantage point from which to observe the inner activity of the community, it also necessarily involves a place from which to move to greater levels of participation in the culture of the community. Learning is, therefore, not so much concerned with replicating the performance of others or acquiring knowledge transmitted during instruction, but rather occurs through becoming part of the community and having access to a wider range of ongoing activity in its practice.

An important aspect of legitimate peripheral participation involves learning the language of the community and how to talk to other members, and so Lave and Wenger (1991) distinguish between *talking within* and *talking about* the practice of a community. Talking within the practice of a community is a sign of full participation in its shared repertoire and is essential to the task of negotiating new meanings, transforming identity, and developing greater levels of participation. Talking about the practice of a community from outside of it is usually associated with the formal learning of beginners, since the effect of this talk is not full membership of the practice because it necessarily occurs on the edges of the community. The nature of the learners' discourse can therefore serve as a useful distinction between theory (talking about) and practice (talking within).

Participation in the Community of Practice of Mathematics Teacher Education

A growing number of researchers have employed Lave and Wenger's (1991) theory of communities of practice to describe the experience of learning to teach mathematics (see, for example, Adler, 1998; Goos & Bennison, 2006; Smith, 2006). In particular, the notion of legitimate peripheral participation in a community of practice can provide a rich conceptual framework for understanding pre-service teachers' knowledge acquisition during their practicum because the nature of such participation emphasises both the personal and social nature of learning. In this sense, learning to teach is concerned not so much with developing new skills, but rather with the individual pre-service teacher's socialisation into the ways of thinking and operating of the practicum school, the

supervising teacher and the other members of the teaching staff, and how each individual is influenced by membership of these communities.

The role of legitimate peripheral participation also highlights the importance of on-going activity in the actual practice of teaching as the primary means by which a person learns to become a teacher. In Lave and Wenger's (1991) view, becoming a full participant in the community of secondary mathematics teaching involves engaging with the everyday discourse of practising teachers and actively building relationships in that community by doing things together with practising teachers. Access to and use of the tools and artefacts in the community are crucial if pre-service teachers are to legitimise their peripheral participation and make visible the meaning of the shared repertoire of mathematics teaching, thus enabling the development of more complete and richer forms of participation (Graven, 2004).

Participation in a community of practice is not unidirectional. It involves a good deal of give and take on the part of its members because engagement in a community shapes the experience of individuals who, in turn, help to negotiate new forms of community by virtue of the diversity of their interactions within it. In other words, the community of practice of mathematics teaching inevitably grows according to the endeavours of its members, both in terms of what they know and how they act within the community. Pre-service teachers also make an important contribution to their practicum experience by virtue of their personal history and previous experience of schooling, which act as a prism through which they view the practicum classroom. However, their lengthy "apprenticeship of observation" (Lortie, 1975, p. 61) as pupils can also make it more difficult for pre-service teachers to imagine alternative approaches to teaching from those which they received in their own education. The likelihood is that the lessons the pre-service teachers observe during their practicum placement are not radically different from those they experienced when they were in high school and this produces a "familiarity pitfall" (Feiman-Nemser & Buchmann, 1985, p. 56) that is difficult to overcome.

The physical and social settings in which pre-service teachers undertake the activity of learning to teach are an integral part of the learning that takes place within them (Putnam & Borko, 2000). The learning environment is of particular importance when the reform approach to mathematics teaching taken in the university methods course is not matched by a similarly progressive stance in the practicum school and there is growing evidence that the pre-service teachers' interactions with the supervising teacher and the classroom climate of the practicum are powerful influences on pre-service teachers' own practice (Shane, 2002). So, even though pre-service teachers are regularly exposed to progressive pedagogical approaches at university, they nevertheless often shift to more traditional teaching practices as they move into the practicum and begin their teaching career.

Most pre-service secondary mathematics teachers excelled at the subject when they were in high school. They are likely to have been placed in the top mathematics classes and to have responded positively to the traditional teaching that they received, achieving good marks on written tests and examinations. Their initial identity formation as mathematics teachers was shaped by these experiences and Zeichner and Tabachnick (1981) suggest that their traditional views remain latent during the pre-service teachers' university studies only to reappear when they enter the classroom. The prospective teachers are sustained in the culture of teaching they first observed as pupils, a process of identity formation that is reinforced during the practicum (Frykholm, 1999). However, they are still capable of

talking *about* reform-oriented mathematics teaching or writing university essays that espouse the benefits of student-centred learning.

During the practicum, opportunities to re-imagine other forms of teaching mathematics are limited, largely because the pre-service teachers tend to focus almost exclusively on the technical aspects of teaching, especially classroom management and organisation. They plan lessons that are often tightly structured and predominantly teacher-centred because they believe that such an approach is more likely to discourage student misbehaviour. During lessons, they are more concerned with monitoring their own actions than attending to students, and often fail to notice whether any significant student learning is taking place. Thus the chance of alignment between the community of the university methods course and that of the practicum school is severely restricted.

This paper focuses on a small group of pre-service secondary mathematics teachers and seeks answers to the following research questions.

1. Which factors influence the pre-service teachers' classroom practice during their practicum experience?
2. Based on their practicum experience, what pedagogical approaches do the pre-service teachers intend to use in their first year of teaching?

Method

The Grad Dip programs at Macquarie University and the University of Technology, Sydney [UTS], are both one-year, full-time equivalent, professional qualifications for secondary teaching. They are comprised of units in education, curriculum, methodology, and a supervised professional experience practicum of 10 weeks duration. The Grad Dip is available to graduates with academic qualifications in mathematics or a related area of study and most students are mature-aged and have decided to train as mathematics teachers after some previous work experience. At Macquarie, the practicum is completed in a single school under the direction of one teacher, sometimes in small blocks of one or two weeks, but predominantly on one teaching day per week over the course of an entire school year. At UTS, students undertake the practicum in two five-week blocks in separate schools and so have a separate supervising teacher in each school.

All applicants for the Grad Dip at Macquarie and UTS were invited to participate in the research project. A random sample of 16 pre-service teachers (eight from each institution) was subsequently taken from those applicants who accepted a place in the Grad Dip at their chosen institution and returned a signed consent form. The students were interviewed immediately prior to commencing the Grad Dip (February), approximately half way through the program after they had completed at least twenty days of the practicum [June], and at its conclusion (November). Eight participants were involved in the middle and final interview rounds, which are reported in this paper.

The pre-service teachers were interviewed individually for approximately 20 minutes on each occasion. The interviews were semi-structured and designed to investigate how the pre-service teachers interpreted their practicum experiences. We were particularly interested in the factors that the participants identified as playing a major influence on their teaching practices. We also wanted to hear about the style of mathematics lessons that the participants observed during the practicum and the extent to which the pedagogy of their supervising teachers differed from the reform approach taken at the university. In the final interview, we also asked the participants to look ahead to their first year of teaching and

discuss how they intended to reconcile these apparent differences. All of the interviews were recorded and transcribed for later analysis of recurring themes.

Results

The Practicum Experience

The participants in our study recognised multiple influences on their teaching, both while they completed their practicum and when they reflected on the experience after it was completed. The pre-service teachers often recalled how the classroom practices of their supervising teachers fitted well with memories of their own time as high school mathematics students. The student-teachers reported that most of the mathematics lessons observed during their practicum followed a familiar pattern: reviewing the work from the previous day, some teacher exposition of new material, worked examples on the board, and individual seat work for pupils to practise new skills and procedures. The most common description reported by the pre-service teachers was one of "chalk and talk" lessons where pupils completed many textbook exercises, working predominantly on their own. The student-teachers' own high school experiences bore close resemblance to their practicum observations, a fact which served to reinforce this style of teaching as an acceptable and workable model of pedagogy.

The expectations of university lecturers also had some influence on the pre-service teachers' pedagogy during their practicum, but these were often dismissed as unworkable in the "real world" of the classroom. For instance, some pre-service teachers believed that the reform teaching approaches encouraged by university staff were more useful for high-achieving students than the predominantly low-ability classes they were usually required to teach.

In contrast to the university lecturers, the practicum supervising teachers were far more influential in shaping the participants' teaching styles. Typically, the participants in our study characterised their supervising teachers as "traditional" and claimed that it was difficult to experiment with working mathematically tasks in the classroom because the supervising teacher was dismissive of such an approach. This was most apparent when the student-teacher devised a lesson plan focusing on group work or activity-based learning but the supervising teacher insisted that the plan be changed to a more teacher-centred method of delivery. The pre-service teachers often reported that their mentor teachers complained that the reform approaches encouraged at the university did not allow for the completion of a sufficient number of practice exercises during lessons.

The pressure to conform to the supervising teacher's style was also seen as a factor in determining the kind of final practicum report that each student-teacher would receive. Even though the determination of the student's grade for the practicum rested ultimately with the university, the report of the supervising teacher was a high-stakes document in the minds of the pre-service teachers because they used it in job interviews as evidence of their teaching capabilities. The pre-service teachers concluded that the best way to guarantee a good report was to follow closely the supervising teacher's advice, which usually meant teaching in a traditional way.

Classroom management was an important consideration for most student-teachers and although many commented that the textbook-based lessons of their cooperating teachers were not very effective in terms of student learning, the pre-service teachers felt that such

lessons were easier to teach because "you don't have to prepare as much" and you can have "more control over the class". The student-teachers wanted to keep a tight rein over their classes until they had established themselves in the role of the teacher and sensed that students respected their authority. They did not feel comfortable in allowing students too much latitude through the use of investigations or open-ended tasks and tended to "write things up on the board and get them [the students] to copy into their books" because they regarded this approach as more likely to lead to compliance from students. The pre-service teachers wanted to concentrate on developing their basic teaching skills and thought this would be easier if classroom management concerns were minimised, and the best way to guarantee this was to use teacher-centred strategies.

Often the student-teachers linked the style of teaching they employed to the academic ability of the class. As one commented, "If you're teaching a really good class that you can trust to do stuff, then it's different". Another noted that "with really weak students … you just [say], 'this is a result you need to learn'". However, the supervising teacher was often reluctant to allow group activities with brighter classes because of the perceived need to cover as much content as possible in preparation for examinations and to ensure what the supervisor regarded as the best preparation for the senior years.

Some of the participants in our study did begin to reflect more critically on the teaching they had received as pupils themselves and on the supervising teacher's lessons they attended during the practicum. One student-teacher stated that the traditional approach "never really fitted with the way I learned" and that it was "a bit of a lazy way to teach". Another compared his own learning in university methods classes and workshops with observations of pupils during the practicum and concluded that a student-centred approach was a more effective pedagogy. But these student-teachers also reported that they found it difficult to depart too far from the style of the supervising teacher because the pupils reacted against any change from the traditional classroom routines to which they had become accustomed. As one student teacher remarked, "It was their [the supervising teacher's] school and their classroom, their students".

The student-teachers were naturally inexperienced and lacked some basic skills in promoting class discussion through questioning and motivating students, so their first, tentative steps in using alternative teaching strategies were usually not very successful and often resulted in minimal student participation or learning. One student-teacher commented, "I said [to the class], 'Alright, go and start discussing things for yourself', but they just talked and carried on". She then concluded that "student-centred [teaching] is a harder way to teach". Another pre-service teacher recognised that one more likely source of these difficulties was that the pupils, too, lacked experience in this type of classroom interaction.

> The kids are not used to learning that way [group activities] and they don't really know what to do … They have not yet learned to learn that way, I believe.

Since the student-teachers' initial attempts at reform approaches fell so short of their expectations, they were reluctant to try them again, particularly when they perceived that the supervising teacher, who would later write their final practicum report, was also unimpressed by these lessons.

Looking Ahead

As part of the interviews, we asked the student-teachers to look ahead to their first year of employment in schools and discuss how they intended to teach, and the factors that they imagined might influence their classroom practice at that time. All of the participants in our study expressed the desire to "eventually" conduct lessons that conformed to the reform practices they had been exposed to at university. However, they expected to find themselves in mathematics faculties much like those they experienced during their practicum: ones where traditional teaching approaches were the norm.

A common theme among the pre-service teachers was that when they started teaching in the subsequent year, they did not believe they would have much support from other mathematics staff members because most of their colleagues would not be accustomed to a reform style of teaching and therefore could not offer practical advice on how to implement it in the classroom. As one pre-service teacher noted, "it means you don't have as many people to ask for help" and, as a result, there would not be the resources and ideas available that could be shared with a new teacher who intended to adopt a student-centred approach.

The student-teachers' practicum experiences convinced them that the workload of a new teacher would be very demanding, especially in terms of lesson preparation. They felt that the additional requirement of imagining activities and organising materials for more creative lessons that were designed for a student-centred approach would be excessive. Therefore, it would be necessary for the beginning teachers to "resort" to a style of teaching they believed to be ineffective in order to survive the early years of teaching while they gathered resources for themselves. As one student-teacher stated "it won't be practical for me to be spending hours doing research for an hour lesson".

Another student-teacher in our sample was concerned that that his colleagues would be unimpressed if he attempted to use activities and investigations with students because they would not regard this as an acceptable form of teaching, especially if there was a lot of noise and commotion coming from his room. He felt that the other staff members would

> see my classroom as messy, as noisy, as not good teaching because for them good teaching is a completely quiet classroom … with their heads down doing their exercises.

To avoid any perceived conflict with other teachers, this student-teacher concluded that he would be a "textbook teacher" (i.e., teach predominantly from the textbook) for a while and then gradually introduce other activities for his students when he thought he could maintain better control over the class. Others noted that students, too, had certain expectations about the kind of lessons they would receive when they arrived for class and that they "expect a certain style of teaching in mathematics", which typically meant a traditional approach. Thus, the pre-service teachers thought that it might be difficult to overcome their students' demand for instrumental rules and procedures and teach for relational understanding using an investigative or discovery style.

As a result of these factors, most of the student-teachers planned to use a mix of approaches as they started their first year of teaching; some believed that they would introduce group work very gradually, whereas others wanted to start relatively early so that they could begin to train their students according to their reform pedagogy. As one participant remarked:

> As the year goes on I think is when you give kids more and more responsibility for themselves … but not let them go too far until you know that when you say "Ok class, now sit back and listen to me", you know they're going to listen to you.

All of the student-teachers in our study commented favourably on the fact that they would no longer have to contend with the difficulties associated with teaching classes that essentially belonged to another teacher. There would not be the conflict and confusion of classes being taught in more traditional methods for most of their lessons by the supervising teacher, and then occasionally using more student-centred approaches by the pre-service teachers, when they were permitted to do so. In a sense, the student-teachers recognised that, from now on, they would be master or mistress of their own destiny.

Discussion

One of the consistent themes to emerge from our interviews is the fact that pre-service teachers struggle with a number of competing (and perhaps conflicting) demands in their professional preparation. This is especially so during the practicum where student-teachers are in a period of significant identity transformation as they begin to participate in the community of practice of secondary mathematics teaching. The process is made more difficult because although the student-teachers have some responsibility for the classes they teach, the ultimate authority still rests with the supervisor. And although the pre-service teachers have some freedom to develop their individual teaching persona, they often feel constrained by the style of their supervisor. Moreover, even though student-teachers can plan lessons according to their own ideas, they must nonetheless present them to the supervising teacher for final approval.

So there is an unavoidable tension between one's past experiences as a *student* and the brief intermediate period as a *student-teacher*, when one is beginning to engage in the work of a *teacher*, and is still not fully regarded as a member of the teaching community. The high school mathematics lessons when the participants in our study observed the work of their own teachers were formative encounters and clearly influential, both in imagining a life as a teacher and in deciding to embark on a teaching career. To some extent at least, the student-teachers have to overcome the limitations of these experiences in order to develop new ways of imagining themselves as teachers. Like many intending secondary mathematics teachers, they enjoyed the subject at school and responded favourably to the traditional forms of teaching in their own education. Moreover, they tend to believe that their own students will react just as positively to a similar direct instruction model and so they find it difficult to imagine a need to teach in any other way (Ball, 1988).

Notions of what constitutes "good teaching" are thus formed early on and can prove difficult to shake, particularly because they are often based on the personalities of individual teachers rather than on pedagogical principles (Lortie, 1975). Such initial observations are necessarily from the students' perspective, so the meanings that are attached to them lack any real appreciation for the subtleties of the craft of teaching, which might explain why the pre-service teachers in our study interpreted their practicum experience in fairly simplistic or idealistic terms that conceived teaching primarily as technical competence, particularly in terms of classroom management, rather than as a process of on-going decision-making focused on student learning.

Our interview data suggest a clear division between the social constructivist approaches discussed at university and the more traditional practices of many supervising teachers. Ebby (2000) notes that although practicum classrooms do not necessarily need to be models of constructivist pedagogy, they must provide a place in which student-teachers can at least imagine possibilities beyond traditional norms and experiment with new ways of teaching. However, our research indicates that not only do pre-service teachers have very

limited opportunities to observe reform teaching during their practicum, but also they are also unlikely to receive much encouragement to try it for themselves. Pre-service teachers' identity formation is therefore compromised by the disjointed nature of their university and school-based programs, and the tasks of engagement, imagination, and alignment (Wenger, 1998) become more complex and problematic. As a result, student-teachers sometimes struggle to engage meaningfully in what appear to be two separate communities of practice that are, in many respects, at odds with each other.

Conclusion and Further Research

It is commonly quite difficult to place student-teachers in schools for their practicum and the shortage of those who are willing to act as supervisors often means that there is only a rudimentary screening of supervising-teacher applicants. The comments from participants in our study indicate that supervising teachers appear to see their role predominantly as one of giving advice about the practical concerns of classroom routines and organisation rather than in developing the student-teachers' reflective pedadgogy. We plan to investigate the supervising teachers' perceptions of their responsibilities more fully and test this assertion in a follow-up study.

The trainee-teachers we spoke with often used the language of reform teaching but there are doubts about whether they really understood what they were discussing, since, as Lave and Wenger (1991) point out, it is difficult to talk *within* a community and imagine teaching in a particular style if you have never done so in practice. Indeed, like Zeichner and Tabachnick (1981), we sometimes had the distinct impression that the participants were telling us what they thought we wanted to hear rather than what they really believed. It therefore remains to be seen whether the participants latently hold traditional views that will eventually re-emerge when they are on their own, or if these pre-service teachers really do begin to implement the reform teaching approaches they have indicated that they want to try in their first year of teaching. We will investigate the classroom practices of these student-teachers in our future research.

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