SECONDARY MATHEMATICS TEACHER EDUCATION: REPORT ON A DEVELOPING PROJECT

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At the Auckland College of Education, secondary teachers are prepared for the classroom in a one-year post-degree course. This involves lectures and 13 weeks classroom practice. In 1991 it was realised that the model being used was at odds with the classroom experience of the students.
An action research programme involving lecturers, students and associate teachers in the schools is in process. Its aim is to link the classroom experience to the model of teaching demonstrated at College. The programme has gone through four cycles in the action-research model.
This paper describes the four cycles and reports on lessons learnt during the research. The exciting part of the emerging model is a collegial process which involves lecturer, students and associate teacher working together in the classroom with more experimentation and reflection on teaching as an art. Other benefits are increased cost effectiveness and closer links between College and schools.

At the Auckland College of Education a one year secondary teacher training course is offered to graduates. They are required to do two curriculum subjects, professional studies and an education course. Fourteen weeks, in three blocks, are spent in schools for the teaching practicum. This project arose out of an increasing dissatisfaction with the teaching practicum for the mathematics students. During 1990, the students were reporting difficulties matching their practicum experience with the College experience, and the lecturers were feeling that the models of mathematics education being presented to the students in schools were generally far from ideal. Improving teaching practicum became a major focus for development.

Glossary:		
	pupil	- secondary school students in the classes
	student	- student teachers at ACE
	lecturer	- lecturer at ACE
	TP.1, 2, 3	- teaching practice blocks when students are in schools

Statement of the Problem

The teaching experience is the time when students experiment, take risks, and challenge existing ideas about teaching. Thus they will find a teaching style and methodology which fits their developing philosophy. In schools some students are with innovative, experimental teachers. Such students flourish. In contrast, many students are encouraged to emulate the associate rather than find their own style. These students do not gain the confidence to experiment. A further problem is a lack of a collegial style of assistance.

This research is based on the belief that there are two major factors which will make better teachers: an increased focus on LEARNING and an attitude of continual self-development. It is further assumed that the teaching experience is the setting which is most likely to provide opportunities to develop these characteristics, and that the collegial relationship is the means which is most likely to help students develop in these areas.

Working within the constraints of a school's right to choose the associate teacher, and the student's right to choose their TP school, how do we create a teaching experience which will push students to their limits, consolidate a personal philosophy and style of teaching based on student learning, and develop an attitude of self-reflection and analysis of pedagogy?

Context

Since 1990 the secondary teacher mathematics education course has been based on a model proposed by Maher [1988]. Its premise is that teachers' beliefs, knowledge, judgments, thoughts and decisions have a profound effect on

the way they teach as well as on student learning in their classrooms. The model has three interrelated parts (see fig.1.):

STUDENT AS RESEARCHER

a) Students experience their own learning in problem solving sessions. This is recorded in their journals, and discussed in class. It is analysed to illuminate the the roles of the learner and teacher.

b) Students give diagnostic tests to pupils, interview them, then work with them on overcoming misconceptions. This is an observe - analyse - guide - facilitate cycle. They write a report on the implications for teaching.

STUDENT AS PRACTITIONER

In the Hewet Project model [de Lange, 1988] students learn to design problem driven lessons, implement them using a variety of teaching approaches, and evaluate the results (see fig.2.).

STUDENT AS PHILOSOPHER AND MATHEMATICIAN

Students write down their thoughts on the teaching and learning of mathematics and contribute to discussion sessions on this issue. They are encouraged to create and solve mathematics problems and to view themselves as practising mathematicians.

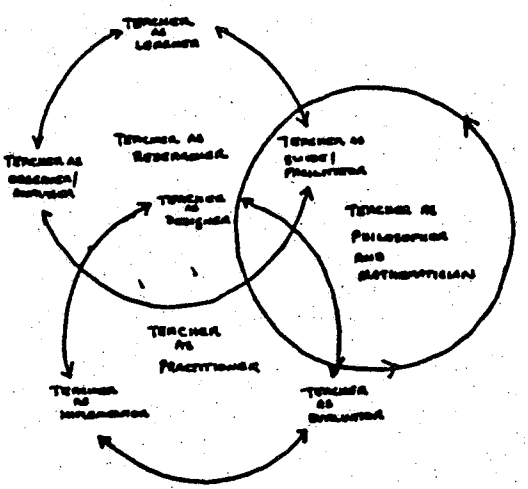

Fig.1

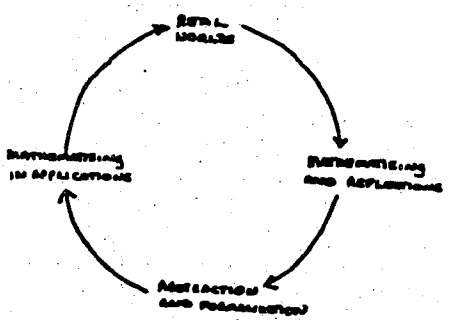

Fig.2

The ongoing development of this course caused a mismatch between the College course and TP, a universal problem identified by Zeichner [1990]. The course focuses the student on the reflection and analysis of classroom learning. Simon and Schifter [1991] describe a teacher as the creator of problem solving situations grounded in real world experiences that are well known to the pupils, thus enabling them to build on already present cognitive structures. The teacher must balance the interests and questions generated by the pupils with the goals of the curriculum. The teacher is the facilitator, asking probing questions, encouraging the exploration of potential pitfalls and misconceptions with the aim of developing more resilient concepts. This helps the pupil to develop bridges between the mathematics in the real world and formalised mathematical ideas. Jaworski [1992] proposes a teaching triad comprising the management of learning, sensitivity to students, and mathematical challenge. "Only students themselves can construct their mathematical knowledge, relative to their own individual experience. In every moment of classroom action, some sort of construal occurs. A teacher needs to influence and interact with this construal."(ibid, p14)

On the other hand, New Zealand mathematics teachers are in danger of become professionally deskilled by increasing administrative and non-teaching pressures and by the provision of cookbook resources. A smoothly operating class is often considered paramount. Teaching proceeds with an assumption that the pupils are learning and teachers often have little opportunity (or encouragement) to diagnose what is blocking the learning of the pupils.

Associates' focus for the training of students on teaching practice is on classroom management and teacher-controlled learning. They pass on the 'tips of the trade', how to survive in the classroom, and how to become a good technoteacher. Zeichner [1986] describes this as a 'utilitarian teaching perspective'. This view of teacher training is grounded in teachers' own training experiences. Grossman [1992] sees this reproduction of the traditional role of the

associate teacher as a formidable obstacle. Taking on a student teacher is seen as an 'on-site sabbatical', not an opportunity for personal learning. The other obstacle cited by Grossman is the 'expert - novice' relationship which deters the teacher from sharing the implementation of new teaching approaches.

In Zeichner's [1986] view, efforts to improve TP must be closely linked to efforts to reform the entire enterprise of teacher education, in which the teacher's role is linked to continued learning over the course of a career. He reports [Zeichner 1990] that a large number of current innovations in TP have been aimed at preparing students to be researchers of their practice. Thus teachers' practical theories are accorded a legitimacy. He has labelled this an inquiry-oriented practicum, where the school no longer serves as a model for practice but becomes a social laboratory for study. The obstacles experienced in Auckland during TP relate to Zeichner's list [1986 & 1990]. They are:
(1) the dominant view of TP as an exercise in apprenticeship;
(2) the lack of an explicit curriculum for the TP and the lack of connection between what the students are taught at College and in the schools;
(3) the uneven quality of TP supervision and the lack of formal preparation for both College lecturers and associates;
(4) the fact that schools are not set up for learning to teach; and
(5) the discrepancy between the role of the teacher as a reflective practitioner (as embedded in the goals of teacher education), and the role of the teacher as technician (which is dominant in practice).

In this action research programme the TP has been altered to increase the opportunities for research and reflection. Our belief is that this can happen through collegial models of interaction and by freeing the students from classroom management fears.

The Four Cycles of the Programme to Date

PLATFORM
Four selected students and four selected associates were paired with a lecturer for TP.3. 1991. Group meetings and team planning sessions were held and all three shared in the planning and teaching of the unit.
TEAM-TEACHING
Where possible on TP.2. 1992 lecturers visited students more than once and on the second or later times the lecturer became actively involved in the teaching of the lesson.
STAGE
On TP.3. 1992 students who were at the same school were paired together for one maths class. They shared planning and teaching
CROSS-CURRICULAR PAIRING
On TP.1. 1993 some students were paired to observe, team-teach and give mutual feedback.
In addition students were given the opportunity to pair with others in different subject areas.
INTERNSHIP???

Cycle.1. PLATFORM

Students reported teaching practice as unsatisfactory. It was observed that students did not focus on learning, nor were they seeing good mathematics teaching. It was decided to work intensively with a few students. The objectives were to work closely with associates whose teaching was consistent with the College programme, and for lecturers to become involved as teachers in the classroom. All participants were to be partners in a process of personal development.

Four selected students and four selected associates were paired with a lecturer for TP.3. 1991. Group meetings were held, ethnographies of the classrooms were made, and team planning sessions developed the units of work. All shared in the teaching and kept journals. A report was written describing the project and making a series of recommendations [Pfannkuch & Barton, 1991].

All participants were positive about the project, and the opportunity it provided for everyone to think about teacher development. All felt they had gained considerably. The students improved their teaching techniques in that the pupils were given work that was accessible, that challenged them to think, and that included strategies for

generating mathematical enquiry. In the development and teaching of a unit the realistic learning model (see Context) was successfully used. The lessons that were formally evaluated were some of the most creative and interesting lessons that the lecturers observed that year.

The recommendations from the Report included:

◊Associates should be offered training, should be rewarded so that their work was valued.

◊Associates need to be involved with the student and lecturer, and should meet students before TP.

◊Lecturers should visit each student more than once each TP.

It was concluded that working with students rather than watching them was likely to lead to cooperative styles of teaching.

Cycle.2. TEAM TEACHING

After the successful experience of the PLATFORM cycle, it was decided to develop a more collegial working relationship with all students. The reason this was not happening with the associate was probably because of the mismatch between the associates and lecturers view of TP.

During TP.2. 1992 the lecturers attempted to visit every student twice with the same class. On the first visit the lecturer gave a formal observation, on the second visit the lecturer became involved in the planning and then taught with the student. Students particularly enjoyed planning together, and they also watched the lecturer demonstrate skills, e.g. drawing ideas from pupils' discussion. This cycle also included an attempt to establish a closer relationship with associates. Associates were encouraged to be present both during the lesson attended by the lecturer and at the debriefing afterwards. They became more interested in the process of teacher education and it was found that the points of view of the associate and the lecturer were closer than had previously been realised. More than previously, the discussions after the lesson centred on learning rather than management.

Students and associates responded positively to these attempts at a collegial TP. In particular the associates became actively involved in the practicum and more aware of the orientation of the lecturers. In turn, the lecturers renewed their experience of the realities of the classroom, and were perceived to be practitioners still in the process of learning. Thus the mismatch was reduced through movement from both sides. The benefits of a collegial model of TP were reinforced.

Cycle.3. STAGE

Despite the success of the team teaching, it was still impossible to plan and teach with all the students. In TP.2. two students placed in the same school had worked closely together and tried out each others ideas in their classrooms. And in July the students worked in pairs on a learning investigation assignment which went extremely well. These two events provided a foundation to try team-teaching in pairs. (Pairing students has been attempted in the primary section of ACE and overseas [Zeichner, 1990, p116, Copeland & Jamgochian, 1985]). Some of the anticipated benefits were: more communication about the topic being taught; students moving into collegial mode; opportunity to take more risks and try better teaching strategies; and more time to focus on learning.

Eight pairs of students worked together. They were asked to experiment, to try problem driven lessons and to use a variety of teaching strategies. Two visits were made by the lecturer to each pair, who became involved in the teaching of the lessons under the direction of the pairing. Both lecturers and students kept a journal, and specific feedback was sought from students and associates. At a meeting for associates, the experimental nature of the plan was explained and feedback sought. The associates welcomed the opportunity to be part of the experiment in team-teaching, and expressed surprise that the mathematics education focus was learning not classroom management, and collegial rather than expert/novice.

The pairing trial was effective mainly because students were together all the time: planning, teaching, and talking after the lesson. Compared with lecturer/student team teaching, there was much more continuity. This was useful for both non-innovative and innovative students, the former because they could 'see' what had been described at College when given the opportunity to try things out, the latter because this was a perfect opportunity to experiment with new-found skills. The main advantages were: that for one class they could concentrate on learning rather than management; that together they took risks with new approaches that they would not have countenanced on their own; that it was stimulating to bounce ideas and discuss how to teach a class with someone who had a

similar view on the teaching of maths; that they supported one another in all aspects of the lesson; and that they learned strategies for teaching different things and handling management situations from one another.

Lesson planning unexpectedly took longer as more discussion ensued, so that the reasons for teaching in a particular way had to be clarified. This resulted in what the students thought were better quality and more interesting lessons. The lecturers noted that the paired students created more problem-solving situations in which pupils were active participants in the maths learning.

Associates reported that the students were more intensely on task, were thinking more, took more risks and the learning for pupils was improved. The discussions afterwards, often involving the associate, were interesting and focussed on improvements to the lesson for better learning. Some associates were worried about students not learning management skills.

The team-teaching worked best where the students were compatible and had worked out how to team-teach together. One disadvantage was that the level of uncertainty was increased in the class and each had to think quickly on their feet as they took cues from each other. The general impression of the pairs was the increased energy level and the enjoyment of teaching and supporting one another. A few students felt that the team teaching was not completely successful for them because of personal differences with the other student. They recommended more care with, and student control of, the pairing process. Despite this, they all felt that they benefitted from the experience and recommended that team teaching should continue next year.

From the lecturers' perspective the pairing worked well where the students were similar in ability and confidence about teaching. In cases where there was discrepancy in ability the weaker person definitely benefitted more than the other. It was noted that the associates were present more often, probably because they felt engaged in the process of teacher education. They were also drawn in by the more frequent and participatory lecturer visits and the idea of the classroom as a place for teacher development, equally for the associates as for the students and lecturers. Thus teacher change was a positive outcome of the trial for associates. However the question remains as to whether they will continue to experiment with their teaching as a result.

There is no doubt that students put much more into their learning, and that they made more progress towards effective teaching those from the previous year. This may have been because they were further forward than last year's group, or it could have been a result of the opportunity to operate in a collegial style. It was also apparent that students were more critical of their educational practice, and could justify their critiques in a way they were not able to do earlier in the year.

This trial began to address each of the five barriers to student learning mentioned above:

1). The dominant view of TP as apprenticeship was circumvented because students were not as reliant on their associates. Furthermore, with two working together, management was not a problem and therefore the feedback from the associate had to be on the teaching strategies used and the learning taking place. This also helped to break down the expert/novice relationship because it took the focus off teacher skills and the associate's style.

2). Students were given explicit instructions to use the pairing trial to experiment, and the associates were drawn into another orientation by becoming party to the trial and the philosophies which generated it. Thus the mismatch between school and College was reduced.

3). Those students on the trial were given special attention by both lecturers and associates. It is possible that some of the success of the project resulted from a Hawthorne effect, however a subjective assessment is that the quality of supervision was greater than for other students as the associates were drawn into the student - lecturer - associate partnership.

4). Although the schools were still not set up for learning to teach, special arrangements were made for the pairing trial.

5). The discrepancy between teacher as reflective practitioner and the teacher as technician was resolved by putting the latter concept on one side for the duration of the trial.

Students were developing a different model of mathematics teaching and developing an attitude of self-reflection and analysis of pedagogy. A major issue which remains is that pairing may be a high-order skill so that learning how to team-teach effectively takes the focus away from the other aspects of the TP. If so, can this be alleviated by team planning and a slow build-up towards team teaching?

Despite the success of the trial, and its feasibility as a permanent feature of TP.3., there are some implications to be considered:

1). If pairing enables experimentation and trying out new ideas, the practicalities of teaching must also be part of a student's experience. Students involved in this programme need to have another mathematics class on TP.

2). Students will not gain as much if they are in a relationship which they find difficult. Pairs should be chosen by the students, and, if possible, given a trial in some assignment work prior to TP.
3). Students need to be trained to team-teach and to observe. This can possibly take place before and during TP.2. with the lecturer, as well as in sessions prior to TP.3.
4). The increased links with associates have been shown to be most valuable. The pairs which worked best had associates who both participated in the classroom and agreed with the philosophy of team-teaching and self-reflection. All means to promote this relationship should be pursued.

Where To Now?

For TP.1. the exploration on improving the TP experience has become cross-curricular and pairs of students in two professional studies groups will observe each other and give feedback on teaching performance. Four mathematics students are trialling team teaching at their request. In preparation the students and lecturers learnt observation and feedback techniques which are designed to give the student autonomy over the feedback process and which encourage self-assessment.

On all TPs associates will be encouraged to adopt a collegial style with the students. Before TP.2. team-teaching will be built into the mathematics course by focussing on what happens when students pair for planning, experimentation, presentation; and what happens when the lecturers team-teach. On TP.2. lecturers will team-teach with students on the second visit. On TP.3. the paired teaching model will be used. The aim will be to promote a partnership between associate-students-lecturer for the TP in which all are expected to plan, teach, evaluate, observe, analyse and experiment.

Ways to link College with the students' first year of teaching are being explored. Is it possible to work more closely with the mathematics adviser or to provide in-service time at intervals throughout the first two years of teaching?

Mathematics teacher training in Auckland is moving towards an inquiry oriented and reflective model of learning to teach. Looking beyond this year, perhaps the next step is to have an internship model similar to that at the University of California, San Diego [Smith & Souviney, 1993] where two students share a class for the whole year with a lecturer working collegially with the students in the classroom. It has been noticed that students who have taken mathematics education papers at university bring a wider perspective to mathematics education and are more responsive to innovation. Therefore, in the year before internship, the students would be required to take such papers along with a practical component in schools.

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