

Professional Development of Teachers of Mathematics Through Extended Collegial Dialogue: The ACT Mathematics Quality Teacher Program

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Perceived pressure to cover content in limited time often results in secondary mathematics teachers valuing “quick-fix” professional development activities that focus on classroom materials over extended programs that promote professional growth through discussion and reflection. The Australian Capital Territory Quality Teacher Program (Mathematics) commenced as a collaborative exercise in developing curriculum materials, but evolved into a process of reflection. This evolution, and the resulting change in teachers’ beliefs, is described and discussed from two perspectives: that of the facilitator and a participant.

The QTP

The Quality Teacher Program (QTP) is an Australian Commonwealth Government initiative designed to develop and integrate new pedagogies, diversify teaching roles, take teachers to the global community, enhance teachers’ power to direct students to broader knowledge bases and, as a result, raise the status of teaching as a profession. It focuses on the areas of literacy, numeracy, information and communication technology, mathematics, vocational education and indigenous education. The major project in the Australian capital Territory is the Curriculum Integration Model (CIM), which focuses on infusing information and communication technology into pedagogy across Key Learning Areas, by involving groups of teachers in designing curriculum materials that will embed ICT into everyday practice. Two smaller projects in science and mathematics were also conducted. The QTP Science project developed support materials to promote science-based excursions in the community, and offered workshops and short courses. The QTP Mathematics project targeted teachers in the transition years from high school (years 7 to 10) to college (years 11 and 12), who were to collaborate in developing a package of materials that would assist teachers to review their teaching practice in line with contemporary teaching approaches, including the integration of ICT.

Mathematics QTP in the ACT

In June 2000 an initial steering committee, including project personnel, teachers and an external consultant, met to discuss possible directions and strategies for the mathematics QTP in the ACT. The transition from high school to college was identified as a critical issue (Coutts-Smith 1995), particularly in an era of increasing use of technologies such as computers and graphics calculators. This meeting decided that functions and coordinate geometry provided a suitable content focus for the development of curriculum materials that would address these transition issues, and that could incorporate the effective use of new technologies. Groups of teachers from two senior secondary colleges and their feeder

high schools were invited to express interest in collaborating to develop innovative units of work in this area.

The QTP was designed as a professional development program, rather than as a research project. Hence the observations and narratives in this paper have been written with the benefit of hindsight. They describe how the project evolved from one with a focus on materials development to one involving active reflection and extended collegial dialogue.

The Facilitator's Story (Steve Thornton)

An initial full day meeting of the teachers selected to take part in the project was held in September 2000. It was attended by only four teachers, representing two ACT colleges and two high schools. Apologies were received from two other teachers who felt that they were unable to take time from their classes, despite teacher release being provided. Together with the ACT DECS Numeracy Officer, I acted as facilitator for the day.

QTP 1

After a brief introduction to the aims of the project, teachers were given an opportunity to raise issues concerning the transition from high school to college that they felt should be addressed in the project. Five issues were identified as inhibiting students' progress in mathematics, and preventing the introduction of investigative or problem-centred pedagogy, or the use of technology. These were:

- The loss of time for mathematics, often including longer periods with less frequent contact, with no corresponding reduction in content;
- The range of abilities with which students enter high schools or college;
- The unwise choices that students often make at college, with the resultant high proportion of students attempting courses in which they are unlikely to succeed;
- The lack of access to computer facilities within the school; and
- The continuing need for students to learn basic facts and formulas.

The discussion was essentially negative, focusing on problems rather than possibilities. As facilitator I attempted to draw together the threads of the conversation, and to draw the participants' attention to readings that may be relevant to the issues identified. The group discussed the readings described below during the second session.

Hadamard (1996) described the stages of the thinking process through which professional mathematicians such as Poincaré and Einstein commonly progressed as preparation, incubation, illumination and verification. Drawing on this study, the group discussed what was really meant by the lack of time in the mathematics curriculum, and whether the issue was really time to cover content or time to think deeply.

The group also discussed what it really meant to understand mathematics. We looked at the meaning of mathematical understanding as described by writers such as Skemp (1976) and Carpenter & Lehrer (1999). The group agreed that much of the focus of school mathematics was developing instrumental understanding, in which mathematics was seen as a set of isolated skills or processes. We looked at what "ability" really meant in this context.

The group discussed whether the seemingly frequent making of unwise course choices in year 11 and 12 was actually a function of students' unrealistic assessment of their own mathematical capacity, or whether it really highlighted a deeper issue of students' failure to reflect on their own learning. The importance of students developing effective learning

behaviours (Corkill, 1999) and productive habits of mind, such as flexibility, curtailment, logical thought and metacognition (Krutetskii, 1976) was highlighted.

Although lack of access to appropriate technology was identified as a problem, we tried to focus on how technology could be used to create a community of learners (Galbraith, Goos, Renshaw & Geiger, 1999) in which deep, shared understanding of mathematics was valued. Participants suggested that their current experience was that of technology being seen frequently as master, less frequently as servant, and seldom as a partner in learning or an extension of self.

While participants agreed that facts and formulae were important in developing students' mathematical facility, there was some discussion about how much students needed to remember, and about which facts or formulae were really important. The group developed a long list of concepts associated with functions and coordinate geometry, and attempted to link them in a concept map. This concept map was used to set priorities for the development of suitable curriculum materials.

One further full day meeting was held during 2000, involving the original four participants and some teachers who had not previously been part of the project team. The influx of new participants, some of whom brought their own agenda to the discussion, resulted in a lack of shared understandings, and consequently created some disunity in the group.

Throughout these discussions, the agenda of developing curriculum materials remained, and the team felt pressured to commence this task. Two sub-groups of teachers were formed, each with a brief of writing a unit of work. These sub-groups rapidly became isolated individuals, each developing his or her own materials.

As facilitator I found the process immensely frustrating. It seemed to me that the project brief had been developed hurriedly, with a focus on deliverables, an emphasis which flew in the face of the literature on effective professional development (Loucks-Horsley, Hewson, Love, & Stiles, 1998). Loucks-Horsley (1999) stresses that providing time, contexts, and support for teachers to think and work at resolving dissonances is essential for professional growth. Askew, Brown, Rhodes, William and Johnson (1997) found that participation in extended courses of professional development in mathematics was strongly related to belief orientation, and with pupil gains. Thus effective professional development must be an extended process involving deep reflection on teachers' beliefs, knowledge and practices. A learning environment in which mathematical knowledge is fixed and owned by experts, in which mathematical learning is a process of memorisation and recitation of procedures, and in which timed tests determine what is valued by both teachers and students, seems so firmly entrenched in teachers' everyday practice that new materials or activities become subservient to the traditional culture of the school mathematics classroom. In reflecting on the process during 2000, I suggested that the culture of the school mathematics classroom, as described by most of the participants, was so robust that meaningful change was unlikely to occur through the existing aim of developing classroom materials.

The lack of obvious collaboration and progress, and the difficulties associated with developing a coherent theme for the materials, reinforced the belief that the project, as initially conceived, was unlikely to bring about the new pedagogies or focus on student learning described in the aims of the QTP. In consultation with the manager of the ACT QTP, we therefore decided to refocus the mathematics project away from materials development, to attempt to make teacher reflection the central activity of the project, and to

introduce teacher narratives as one of the principal outcomes of the project. Participating teachers would be asked to conduct observations in their and others' classrooms, to reflect upon the learning taking place, and to engage in dialogue with teachers in their own and other schools.

QTP 2

The refocused aim of the QTP then became to “promote quality teaching and learning in mathematics, through cross-sectoral discourse involving reflective practice and professional conversation focused on teachers’ work and student outcomes”. The principles underpinning this aim were that teachers needed to engage in professional reflection and discussion, that quality input was vital to professional growth, and that collaboration with other teachers supported quality professional development. These aims and principles stood in stark contrast to the initial aim of designing “a package of materials to assist teachers to incorporate ICT and current research on student learning into their teaching”. It had a clear focus on teachers as creators, rather than end-users, of knowledge.

The QTP meetings that followed this refocusing took a very different turn. The emphasis moved from product to process, from generating materials to writing stories. While the conversation still touched on many of the commonly expressed problems faced by teachers in their daily work, the need to find solutions diminished. By reflecting on videos of their own and other classrooms, such as those in the Third International Mathematics and Science Study (US Dept of Education, 1997), the participants gained a sense of solidarity with each other and with teachers around the world. The value of sharing experiences and of seeing teaching as part of life-long learning became paramount in the participants’ discussion.

Comments such as “Thank you for listening” and “The discussion allows me to question things that bug me and perhaps re-evaluate my feeling about what I teach” were now common in participants’ evaluations of these sessions.

Not all the participants appreciated the change in focus. One commented that “as time progressed and the group decreased the objectives seemed to change and these changes were being imposed from above ... I felt there was an agenda of which we hadn’t been made aware.” Another noted that “much of the later discussions and focus... were not really appropriate to my situation”.

Yet the conversations suggested that the participating teachers’ beliefs about mathematics and learning had changed in a very fundamental way. The problems identified by teachers during the first discussion in 2000 were now seen as opportunities rather than hurdles. The participating teachers appeared to see themselves as learners, rather than imparters of knowledge. The changed tenor of the discussion is exemplified by an extract from a paper paraphrasing a spontaneous conversation that arose at one of the meetings.

Sometimes it’s hard to get started with technology. One of the big hurdles is the time it takes for students to learn the technology. This might seem to take time away from the intended curriculum. But one of the things we have found is that the time taken to learn the technology pays off in the end. Students are then able to do far more, in far greater depth, than would be possible with pen, paper and book alone. We have learnt that you have to be prepared to invest the time to let the students play, and to just become familiar with what the technology can do.

It also takes time for students to learn to talk to each other. That seems to be one of the more surprising outcomes of using technology – students talk to each other more, and learn from each other more. And the quality of the conversation is often different. Instead of talking about if their

answer is right or wrong, the students talk about ideas and concepts. The conversation adds a new depth and dimension to the classroom learning. No longer is the conversation a monologue by the teacher, nor even a dialogue between teacher and students. We are all contributors to the knowledge and debate in the classroom. The conversation is about mathematics as something that is discovered and owned by the community.

Perhaps the most important message we want to emphasise is that teaching is really about learning. Classrooms are learning places, not work places. And technology can help to shift the focus away from teaching, although that's still important, and onto learning.

A Participant's Story (Kerrie Blain)

In September 2000 I was invited to participate in the research circle of the Quality Teacher Program (Mathematics) in the ACT. I teach mathematics at a high school, and accepted the challenge as this was of vital interest to me, as a practising teacher, for a number of reasons.

Firstly some background information – I had spent several years as a relief and part-time teacher in ACT high schools and colleges while having, and caring for, a large family. I then found it necessary to be away from teaching for 14 years. This placed me in the unusual situation of being able to objectively compare and contrast classrooms over the years. During this time, however, I was still very involved in the education and growth of teenagers. I realised that the teenagers of 1984 were vastly different to those of 1998. To my dismay, however, when arriving back in the classroom in 1998, I found that teaching methods in mathematics had changed very little during the intervening years. So my initial aim by being involved in this project was to encourage teachers to adapt to the new climate in education. Teenagers are leading the way. It is obvious that, as educators, we *must* speak their language. This means the efficient use of information and communication technology in the classroom.

The initial challenge delivered by the QTP team was to develop a professional development program designed to incorporate information and communication technologies into the teaching of mathematics in years 9-12, specifically in the topic of coordinate geometry. In so doing it was hoped to encourage all teachers to consider contemporary teaching practices.

I entered this program with the hope of engaging my students more enthusiastically in their mathematics lessons. This was to be across all ability levels. I am motivated to change teaching strategies by students who ask: "When will we ever need this?", or state "This is boring". Our culture is changing, so it is vital that we, as educators, adapt our approach to classroom teaching.

My aims in this project were therefore:

- To engage and stimulate students – making mathematics more relevant using ICT (Aspin 1997) and practical examples;
- To tap into their multiple intelligences, keeping in mind that differently students have their own preferred learning styles; and
- To improve the transition from high school to college.

Students have changed dramatically over the past 20 years; teachers have not. As educators therefore we need to be in tune with our students and present the curriculum in a more exciting fashion to give them a basis and desire for future learning. The school at which I teach was also part of the Pilot Year 9 Exhibitions of Student Learning in High

Schools Project. This project aimed to introduce Roundtable Exhibitions as a form of assessment of student work (ANSN, 1998). I hoped that the mathematics QTP might support the Exhibitions Project to achieve this goal of presenting more exciting and enduring learning.

I joined the Mathematics QTP in October 2000. I found the discussions lively and informative. It was obvious before long that the real benefits of forming such a group were that the discussions not only stimulated all teachers to continue their pursuit of excellence, but also provided a medium for sharing teaching practices, especially in the use of relevant ICT sources.

I was part of a group of teachers from a high school and college, looking particularly at how to make effective use of graphing software in the mathematics classroom. Having previously read and reflected on the potential of graphics calculators for enhancing student learning (AAMT, 2000), I invited a colleague from a nearby college to visit my classroom to give instruction in the use of graphics calculators, and to observe my students using computer programs in the learning of coordinate geometry. I also visited a college class to observe their students using technology. The teachers involved provided verbal and written feedback to each other and videotaped lessons to enable us to observe our own teaching methods. As experienced teachers, this was something we had not done for a long time.

As teachers involved in the mathematics QTP we identified the following outcomes. The QTP:

- Provided an opportunity for professional interaction through professional conversations;
- Promoted transfer of ideas to others within the school community, thus effecting change in colleagues' practices;
- Affirmed our own innovative classroom practices;
- Provided valuable classroom strategies and methods;
- Updated our educational thinking – challenged our pedagogical mindset;
- Promoted self-evaluation;
- Exposed us to broader educational issues through a critical friend who was an educator in a field other than mathematics;
- Helped us to reflect on our own practices and ideas;
- Provided an environment beyond school, time away from the classroom which facilitated valuable reflection and discussion without interruption;
- Provided specific professional development for mathematics teachers;
- Provided motivation to build on what we know and showcase what we do – a collegial activity with both personal and communal dimensions;
- Facilitated cross-sectoral conversations between high schools and colleges; and
- Encouraged teachers as learners who adopted an intellectual commitment to change.

My Conclusions

- Every student can learn mathematics better. We need to continually evaluate our classroom methods realising that different students learn in different ways.
- All teachers can improve their classroom practices by keeping up to date with technology. Teachers must accept change – students are changing, therefore teachers must be able to adapt to this change. Teachers must be learners too.

- It is important to maintain collegial conversation. All teachers face similar problems. Sharing innovative classroom practices could help solve these. This has been invaluable to me in this project. Time – to talk, and therefore to share ideas.
- There is a gap between high school and college which needs to be addressed. Students will benefit if teachers have time to reflect on, and converse, about these problems.
- It is time to change the curriculum. It can and must be improved to suit today's conditions. We must not be restricted by existing curricula. They must be adapted to incorporate modern technology.

Translating the Process into Broader Professional Development

One of the major goals of the QTP was to translate the process through which the participants had been led to reflect upon their own teaching into a broader professional development program for teachers throughout the ACT. The challenge of condensing some eighteen months of discussion into two half-day sessions with an intervening two-hour workshop, particularly given the focus on reflection and narrative, was extremely daunting. In developing the program for the two half-day sessions we attempted to mirror the process of extended professional dialogue, and to develop a blueprint which could be used by other teachers in their own school situations.

By using excerpts from classroom videos, discussion and feedback protocols such as those developed by the Australian National Schools Network (ANSN 2000), and providing suitable discussion stimuli, the teacher and facilitator team was able to establish an environment that promoted active reflection on classroom practice. Teachers participating in the public phase of the QTP stated that they valued the experience of others, the insights into classroom practice afforded by the videos, and the opportunity to discuss their classroom.

I think that one can never underestimate the importance of reflecting on one's practice – the positive as well as the negative.

I feel that we all have something to learn from our colleagues. Hopefully this is taken away and used or at least discussed.

I will closely examine my teaching practices and identify traits viewed in the videos. I would hope to reduce the amount of mechanical formula-based work and increase discovery learning.

I think it would be good to conduct these discussions on a faculty-wide basis.

Among the outcomes identified by other teachers who attended the three session were:

- The opportunity to experience learning similar to that of the teacher participants;
- Introduction to a framework by which participants could engage in professional discourse;
- Reflection on their personal and collegial teaching beliefs and practices;
- Sharing of resources which modelled quality teaching in mathematics; and
- Introduction to strategies for integrating information and communication technology into classroom practice.

Discussion and Conclusions

Much of the professional development provided for teachers of mathematics can be characterised as “quick fix” remedies, providing good ideas and materials that can be used immediately in teachers’ classrooms. While there is always some value in new ideas, such measures are unlikely to make a long-term impact on the beliefs and practices so firmly imbedded in the traditional practice of secondary mathematics classrooms. These beliefs and practices are, in turn, adopted as the dominant culture of the secondary mathematics classroom, a culture which is extremely robust.

The failures and successes of the ACT Quality Teacher Program pointed to the importance of active and structured reflection as a key factor in promoting changes in those beliefs. The long-term impact of the program is impossible to evaluate, at this stage. Whether or not the day to day pressures of the classroom prevent participants from implementing the reflective practices introduced through the QTP remains to be seen. However, for many of the teachers, such as Kerrie, who took part in the extended professional dialogue, the process brought about a questioning of beliefs and a renewal of professional commitment. Their personal narratives make clear that reflection and dialogue are crucial in their on-going development as professional practitioners.

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