

Regional Differences in the Professional Development Needs and Preferences of Teachers of Primary Mathematics

Steven Nisbet
Griffith University
<s.nisbet@griffith.edu.au>

This paper is a report of an investigation of differences in the professional development needs and preferences of teachers of primary mathematics across Queensland. A state-wide survey was employed to investigate teachers' prior PD experiences, their current PD needs, their dispositions towards engaging in PD and their preferences for the timing, duration and location of PD events. The survey data were analysed in terms of geographical location and school size. The majority of primary teachers who responded reported that they had experienced little or no professional development (PD) in mathematics in the previous two years. However they indicated that were eager to participate in such events. Differences in PD preferences were detected among teachers in remote, rural, provincial city and capital city regions and across small, medium and large schools. The issue of PD has become more important since the recent introduction of a new syllabus for Years 1 to 10 mathematics in Queensland and pressures to improve performance in benchmark numeracy tests, and the major education systems will need to design programs of PD to cater for the varying needs and preferences of teachers across the state.

Professional development (PD) for teachers of mathematics is an ongoing issue in Australia and overseas. However it becomes more prominent when a new mathematics syllabus is produced by curriculum authorities. Although a new syllabus for Years 1 to 10 Mathematics was launched in Queensland in November 2004, the state's largest education system is yet to announce a program of professional development for teachers of mathematics to assist them to understand and implement the syllabus. Any PD program produced will need to relate to schools of widely varying sizes throughout the vast areas of the state (from the capital city to provincial cities, rural areas and remote communities), and will need to cater for teachers of varying backgrounds and teaching experience. It is fair to ask whether systems can assume that the PD needs of teachers of mathematics are uniform across the state, or if differences exist in terms of regional and personal factors.

Although regional differences in education have been documented on issues such as participation rates (Australian Bureau of Statistics, 2001), and school effectiveness (Thomas & Smees, 2000), there are only a few studies which have investigated regional differences in mathematics education especially in relation to teachers of mathematics. For instance, Cretchley, McDonald & Fuller (2000) found that secondary mathematics teachers in country districts had more personal influence on their students choosing to study mathematics at the tertiary level than their urban counterparts.

Other studies have shown that PD needs and programs vary amongst different types of schools. For example, Kensington-Miller (2004) investigated PD needs and the success or otherwise of mathematics PD programs in low socio-economic schools. She found that such schools found it difficult to implement PD programs for their teachers – not just one model of PD but four different models. The difficulties were related to the special systemic conditions found in such schools.

Ruby (1999) argues that curriculum practices need to reflect local and regional differences, while at the same time operating within a context of a wider agenda. Incorporating the local as well as global emphases ensures that students are given the support of their local communities. It can be argued similarly that professional

development programs should reflect local and regional characteristics. This paper reports on the PD needs and preferences of primary teachers in mathematics and analyses regional and other differences found across the state.

There is sufficient evidence in the education literature to suggest that PD plays a significant role in improving teachers' practice and subsequently the achievement of students. Anderson (2002) states that ongoing teacher professional development is an essential part of the wellbeing of the schooling system and successful outcomes for students. In its statement of professional standards for teaching mathematics, the National Council of Teachers of Mathematics (NCTM) acknowledges that teachers' growth requires commitment to professional development aimed at improving their teaching on the basis of increased experience, new knowledge and awareness of educational reforms (NCTM, 1991). Nisbet (2004) argues that professional development must be recognised for its potential to change teacher practice significantly, and its important role in improving numeracy outcomes in schools.

In the process of changing teachers' practices, recognition must be given to the role of teachers' beliefs and attitudes as well as teachers' knowledge and skills. The traditional model of implementing curriculum innovation assumes that teacher change is a simple linear process: professional development activities lead to changes in teachers' knowledge, beliefs and attitudes, which, in turn, lead to changes in classroom teaching practices, the outcome of which is improved student learning outcomes (Clarke & Peter, 1993). Later models of teacher change recognise that teacher change is a long term process (Fullan, 1982) and that the most significant changes in teacher attitudes and beliefs occur after teachers begin implementing a new practice successfully and can see changes in learning outcomes (Guskey, 1985). The professional development models of Clarke (1988) and Clarke and Peter (1993) are refinements of the Guskey model which recognise the ongoing and cyclical nature of PD (focussing on knowledge, attitudes & beliefs) and teacher change. The importance of the role of beliefs and attitudes in teacher change was highlighted in a study (Nisbet & Warren, 1999) of the introduction of a state-wide diagnostic instrument for children in Year 2 in Queensland schools. This innovation had been successfully implemented because teachers believed that there were positive outcomes for pupils, and hence they valued the diagnostic instrument's overall effect.

In comparing successful and unsuccessful PD projects, Nisbet, Warren & Cooper, (2003), observed that success was associated with issues such as teacher ownership, continuity, pertinence to classroom practice, opportunities given for personal reflection, and discussion with and support from a mentor. In a synopsis of the PD research literature, Clarke (1994) enunciated key principles of making professional development more effective, including (i) addressing issues of concern largely (but not exclusively) identified by the teachers themselves, (ii) enabling teachers to gain a substantial degree of ownership by their involvement in decision making, and (iii) recognising that changes in beliefs about teaching and learning are derived from classroom practice, and such changes will follow the opportunity to validate, through observing positive student learning, information supplied through professional development programs.

Clarke's (1994) points about teacher ownership and addressing issues of concern to teachers are very pertinent to the design of PD activities and programs. Anderson (2002) argues that teacher professional development has often been a 'top-down' method of training to meet systemic needs while taking little account of teacher's individual needs. However, teachers argue that they understand their professional development needs best and they should have influence and ownership of their own professional development.

experiences. Hence, education systems must attend to the needs of teachers and teacher professional development must be reconceptualised so that it recognises each teacher's ecology and self understanding.

The PD literature includes studies of PD programs where account was taken of the teachers' own perceptions of their PD needs, e.g. with teachers in the TAFE sector (Watson & Chick, 2002), staff from a wide variety of services for people with a disability (Dempsey & Arthur, 2002), and mathematics teachers (Watson, 2001). When such an approach is taken it is found that teachers want PD to focus on their everyday practice (Clarke, 1994). For example, in the domain of physics teaching, it was found that the teachers' greatest needs were in the areas in curriculum materials and classroom resources, especially affordable equipment, assessment tasks and activity worksheets (O'Keefe, 2003).

Where PD has to service large and distant regional communities, such communities need to be supported by centrally developed, high quality professional development programs and improved access to information and resources (Wilson, 2003). Further, Symington (2001) recommends that educational systems should create conditions conducive to teachers actively seeking professional development and then provide organisational support for PD through provision of sufficient funding for programs, and sufficient time for teachers to participate in the activities.

Some studies of PD needs have revealed that few teachers have undertaken any recent PD. For example, few teachers of mathematics subjects or trade calculations in the VET sector have undertaken professional development or further study in mathematics education since completing their initial qualifications (FitzSimons, 2003). This is probably due to the fact that there has been very little provision of professional development for teachers of mathematics in the technical and further education (TAFE) sector and even less evaluation and reporting on such programs (Watson & Chick, 2002). Further, full-time mathematics teachers in the VET (vocational education & training) sector have experienced increasing workloads, and others have been marginalised through casualised employment, so neither group has any real incentive to undertake professional development in mathematics education (FitzSimons, 2003). The hypothesis, that the majority of TAFE teachers do not undertake voluntary professional development activities and that they wait for management to direct them into the programs necessary for the next changes to the vocational education and training system, was found to be true (Symington, 2001).

The current study was designed to analyse differences in the PD needs of primary teachers across the state on the teaching and learning mathematics, their interest in embarking on such PD, the topics they wanted assistance with, and their preferences for the format for programs of PD.

Methodology

This study was conducted by survey method, and was part of a larger study of teachers' beliefs on compulsory numeracy testing (previously reported). The questionnaire contained further items relating to how much numeracy PD teachers had undertaken in the last two years, their willingness to attend such PD, their preferences for the duration, timing, and location of numeracy PD events, along with what topics they would like to be covered. Background variables included the geographical location of the school, school size (i.e. number of pupils), the teachers' grade level, and their years of teaching experience.

A sample of 56 Queensland primary schools, representative of size, disadvantaged-schools index and geographical location, was selected¹ and a total of 500 questionnaires

were sent to the schools (having estimated the number of teachers in each school from pupil enrolments). Although the response rate was small (24.2%), the sample was representative of teachers' year level and position (Year 1 to Year 7, principal, deputy, & mathematics coordinator), teaching experience (1 year to 40 years), geographical location (capital & provincial cities, rural & remote), and school size (small, medium and large).

The data were first analysed to determine global levels of response on items relating to the substantive issues i.e. extent of numeracy PD, willingness to attend PD, the teachers' preferences for the duration, timing, and location of numeracy PD events, along with topics they would like to be covered. Next, the effects of background variables (geographical location of the school, and school size) were investigated by conducting chi-square tests on cross-tabulations of the substantive items with categories of location (Brisbane, provincial area, rural area, remote area) and school size (small schools – up to 100 pupils, medium-size schools – from 101 to 400 pupils, and large schools – over 400 pupils). The effect of teaching experience was investigated using correlation and ANOVA techniques.

Results

Previous PD Undertaken

Approximately half of the teachers reported that they had not undertaken any PD in numeracy or mathematics in the previous two years. Only 13.8% had attended 1 day of numeracy PD, 14.6% had attended 2 days, and only 4% reported having more than 5 days. Differences existed across geographical locations (e.g. the means for teachers in Brisbane schools and remote schools were 2.13 days and 1.57 days respectively), however these differences were not statistically significant ($p > .05$). Nevertheless, one can appreciate that teachers in the capital city would have easier access to PD seminars and courses than their counterparts in remote areas.

Willingness to Attend PD

The majority of teachers (74%) responded positively (i.e. 'definitely' and 'probably') to being willing to attend PD events in numeracy. This response was seen across all geographical locations, but in small schools, more teachers (62.5%) responded 'definitely' than in medium-size schools (22%) and large schools (32%), $\chi^2(15, N = 121) = 44.78, p = .000$. Apparently, teachers in small schools are more eager to participate with their colleagues in other schools and widen their respective discussion circles.

Duration of PD

The majority of teachers (76%) indicated that they would prefer one day or two days to spend on numeracy PD (37% & 39% respectively). Some teachers indicated a preference for a longer time (10% for 3 to 5 days, and 1.6% from 6 to 10 days). This pattern of preferences was fairly uniform across geographical locations, but teachers in small (56.5%) and medium-sized schools (41%) were more likely than those in large schools (34%) to prefer a length of 2 days rather than 1 day, $\chi^2(15, N = 121) = 29.96, p = .012$. Again, teachers in small schools are eager to participate in other schools over longer periods of time.

Timing of PD

The majority of teachers prefer to have PD held during school time (85%) or on student-free days (73%) rather than after school (42%) or in their own time (29%). Having PD in school time was less popular in rural schools than in the other schools, $\chi^2(8, N = 121) = 15.65, p = .048$. Having PD on student-free days was more popular in Brisbane and provincial area schools than in rural and remote schools $\chi^2(4, N = 121) = 13.52, p = .009$. Having PD on student-free days was also more popular in large- and medium-size schools than in small schools, $\chi^2(3, N = 121) = 11.07, p = .011$. One can surmise that teachers in remote areas don't mind giving their own time to PD, probably due to an assumed slower pace of life in rural and remote areas.

Location of PD

Although the overall majority of teachers prefer to have numeracy PD held in their own schools (83%) or in nearby schools (76%), there are differences across geographical locations and school sizes. Fewer teachers in rural schools (67%) and remote schools (43%) prefer to have it in their own schools, $\chi^2(4, N = 121) = 20.09, p = .000$. Fewer teachers in small schools (44%) compared to medium-size (87%) and large schools (89%) prefer to have it in their own schools, $\chi^2(3, N = 121) = 19.61, p = .000$. Teachers in rural, remote and small schools are more prepared to travel to attend PD, just as they are probably prepared to travel for other purposes e.g. entertainment, socialising and shopping. However, most teachers appear to be flexible in the location for PD. The majority of teachers (77%) are prepared to go to a nearby school and 62% are prepared to go to a central location.

Internet

Only 28% of the teachers responded positively to engaging in PD on the internet, and that response was consistent across schools and levels of experience.

Preferred Topics for PD

As shown in Table 1, the most popular topics for numeracy PD were issues-based topics such as using technology in mathematics, learning about the new mathematics syllabus and problem solving in mathematics compared to content-based topics such as teaching number, teaching measurement and teaching space. The least popular topic was analysing the results of the Year 3, 5 & 7 numeracy tests. Only three teachers (out of 121) suggested other topics for PD, the topics being 'assessment techniques', 'assessment and reporting' and 'practical demonstrations with new ideas and take-home resources'.

Overall, the popularity of topics for PD was fairly uniform across schools, however there were differences evident for three topics – 'assisting students with difficulties', 'the new mathematics syllabus', and the 'space' strand of the syllabus. 'Assisting students with difficulties' was a more popular topic in large schools (65%) and small schools (62.5%) compared to medium-size schools (36%), $\chi^2(2, N = 121) = 8.54, p = .014$. 'The new mathematics syllabus' was more popular in Brisbane schools (79%) and rural schools (73%) compared to schools in provincial areas (46%) and remote schools (43%), $\chi^2(3, N = 121) = 10.74, p = .013$. 'Space' was more popular in Brisbane schools (46%) than in provincial schools (29%), rural schools (19%) and remote schools (14%), $\chi^2(3, N = 121) = 8.71, p = .033$. Similarly, 'Space' was more popular in large schools (39%) and medium-size schools (33%) compared to small schools (6%), $\chi^2(2, N = 121) = 6.09, p = .048$. From

these statistics, there does not appear to be any regular or consistent patterns in the topic differences across regions and school sizes

Table 1

Preferred Topics for Numeracy PD in Order of Response

Topics for Mathematics PD	Response (to nearest %)
Using technology	70
New syllabus	68
Problem solving	60
Assisting students with difficulties	54
Teaching number	38
Use of language in maths	38
Teaching space	33
Teaching measurement	32
Teaching chance & data	29
Analysing results of Yr 3,5,7 tests	22

Discussion

The results from this survey raise some concerns in the light of the current situation relating to mathematics and numeracy in Queensland schools. A new syllabus for Years 1 to 10 Mathematics has recently been developed and adopted state-wide, and compulsory numeracy benchmark testing has been in operation for nine years (a state-based Year 6 test since 1996 and federally-initiated Year 3, 5 & 7 numeracy tests since 1998). However, half of the teachers surveyed reported having had no professional development in mathematics/numeracy in the previous two years. It is regrettable that numeracy has taken a 'back seat' to literacy over recent years, despite public concerns raised about literacy and numeracy standards over the last 10 years. If large-scale numeracy PD is organised for teachers there would be a positive response from teachers across the state, especially in small schools i.e. those with less than 100 pupils. [Small schools probably find it more difficult to arrange their own PD, given the lack of critical mass as regards the number of teachers, and the expense of delivering PD to staff.]

The responses from teachers relating to their willingness to attend PD and their preferred format of PD show that they are very eager to participate in PD, and that they would attend for one or two days. This is good news given that teachers of mathematics in other sectors e.g. those in the vocational education sector, are not motivated to engage in PD (FitzSimons, 2002). Even better news is that the majority of primary teachers in the current survey are prepared to go to a variety of locations for PD events e.g. a nearby school or a central location, although, given a choice, most (especially those in Brisbane and the provincial cities) would prefer it to happen in their own schools. Teachers in rural and remote schools seem to be more prepared to travel.

It is clear that most PD events should be organised to occur on student-free days or in school time. The latter has significant funding implications with respect to hiring relief staff, so PD requires adequate funding for it to be received positively by teachers. However, teachers in remote and rural areas are more inclined to give up some free time to

engage in PD, possible because arranging for relieving teachers in remote areas would be more difficult than in the more populous regions where casual staff are more available

Interestingly, only a minority of teachers responded positively to doing PD on the internet. This may change as time goes on and more teachers become comfortable with using computers. Provision of PD on using computers should be well received by teachers in the long run, given the high percentage response to 'using technology' in the survey.

The responses concerning PD topics confirm the findings in the literature that teachers prefer PD that relates to their classroom practice (Clarke, 1994). The popularity of 'the new syllabus' as a PD topic indicates that primary teachers are 'ready, willing and waiting' for PD initiatives organised by the employer or the syllabus authorities. PD organised around the new syllabus as a theme would satisfy not only the need to come to grips with the aims, themes and content of the new syllabus, but also cover the topics of teaching number, space, measurement, chance and data. Although the latter topics/strands were less popular in the survey, they still meet the needs of teachers to focus on their classroom practice and provide specific ideas, strategies and resources for teaching mathematics.

Over the last 10 years numeracy skills have been the subject of much debate and scrutiny, resulting in increased pressure being placed on primary schools to improve numeracy outcomes (Nisbet, 2004). As the levels of teachers' prior PD reported in this study are low, it would be a proper response for education systems and schools to put professional development in numeracy/mathematics high on the agenda, and capitalise on the positive frame of mind that teachers currently have with respect to the matter.

There are implications for the organisation of PD for teachers of primary mathematics from the results of this study, if the differences in their needs and preferences are to be recognised. Teachers in a variety of settings need to be consulted in the process, and different arrangements made for teachers in the various locations and situations, especially in relation to the timing, duration and location of professional development programs.

¹ Staff from Australian Council for Educational Research (ACER) provided assistance with the sample design and selected the sample of schools. The ACER sampling frame is compiled annually from data provided by the Commonwealth and each State and Territory education system.

References

- Anderson, M. (2002) *Journeys in teacher professional development: Narratives of four drama educators*. Unpublished PhD thesis, University of Sydney.
- Australian Bureau of Statistics (2003) *Australian social trends*. Canberra: Author.
- Castle, K., & Aichele, D. (1994) Professional development and teacher autonomy. In D. Aichele & A. Coxford (Eds.), *Professional development for teachers of mathematics* (pp. 3). Reston, VA: National Council of Teachers of Mathematics.
- Clarke, D. J. (1988) Realistic assessment. In D. Firth (Ed.), *Maths counts – who cares?* (pp. 187-192). Parkville, Victoria: Mathematical Association of Victoria.
- Clarke, D. (1994) Ten key principles from research for the professional development of mathematics teachers. In D. Aichele & A. Coxford (Eds.), *Professional development for teachers of mathematics* (pp. 37-48). Reston, VA: National Council of teachers of Mathematics.
- Clarke, D. J., & Peter, A. (1993) Modelling teacher change. In B. Atweh, C. Kanes, M. Carss & G. Booker (Eds.), *Contexts in mathematics education* (Proceedings of the Sixteenth Annual Conference of the Mathematics Education Research Group of Australasia, pp. 167-175). Sydney: MERGA.
- Cretchley, P., McDonald, C., & Fuller, A. (2000) Tertiary students' rankings of the factors behind their choice to study mathematics and computing: A gender and regional study. In J. Bana & A. Chapman (Eds.), *Mathematics education beyond 2000* (Proceedings of the 23rd Annual Conference of the Education Research Group of Australasia, pp. 212-219). Sydney: MERGA.

- Dempsey, I , & Arthur, M (2002) Support staff in a sample of Australian community-based services for people with a disability: Career intentions, personal characteristics and professional development needs *Journal of Intellectual and Developmental Disability*, 27 (3), 201-214
- FitzSimons, G (2003) Mathematics and vocational education in the training sector: Professional development implications for teachers In S Kelly, B Johnston & K Yasukawa (Eds), *The adult numeracy handbook: Reframing adult numeracy in Australia* Broadway (pages 205-214) Sydney, NSW: Adult Literacy and Numeracy Australia
- Fullan, M (1982) *The meaning of educational change* New York: Teachers College Press
- Guskey, T (1985) Staff development and teacher change *Educational Leadership*, 42 (7), 57-60
- Kensington-Miller, B (2004) Professional development of mathematics teachers in low socio-economic secondary schools in New Zealand In I Putt, R Faragher & M McLean (Eds), *Mathematics education for the third millennium: Towards 2010* (Proceedings of the 27th Annual Conference of the Mathematics Education Research Group of Australasia) Sydney: MERGA
- National Council of Teachers of Mathematics (NCTM) (1991) *Professional standards for teaching mathematics* Reston, Va: National Council of teachers of Mathematics
- Nisbet, S (2004) The impact of state-wide numeracy testing on the teaching of mathematics in primary schools In M Hoines & A Fuglestad (Eds), *Proceedings of the 28th Conference of the International Group for the Psychology of Mathematics Education* (Vol 3, pp 433-440) Bergen, Norway: PME
- Nisbet, S , & Grimbeek, P (2004) Primary teachers' beliefs and practices with respect to compulsory numeracy testing In I Putt, R Faragher & M McLean (Eds), *Mathematics education for the third millennium: Towards 2010* (Proceedings of the 27th Annual Conference of the Mathematics Education Research Group of Australasia, pp 406-413) Sydney: MERGA
- Nisbet, S , & Warren, E (1999) The effects of a diagnostic assessment system on the teaching of mathematics in the primary school In O Zaslavsky (Ed), *Proceedings of the 23rd Annual Conference of the International Group for the Psychology of Mathematics Education* (Vol 3, pp 337-344) Haifa, Israel: PME
- Nisbet, S , Warren, E , & Cooper, T (2003) Collaboration and sharing as crucial elements of professional development In A Peter-Koop, A Begg, C Breen & V Santos-Wagner (Eds), *Collaboration in teacher education Examples from the context of mathematics education* (pp 23-40) Dordrecht, NL: Kluwer
- O'Keefe, D (2003) What do VCE physics teachers want from PD? *Lab Talk*, 47(2), 30-33
- Ruby, A (1999) Difference is the essence of humanity *Unicorn*, 25 (2), 71-83
- Symington, L (2001) *Planning for 2005: TAFE teachers perceptions of professional development needs* Unpublished MEd thesis, University of Melbourne
- Thomas, S , & Smees, R (2000, April) *Dimensions of secondary school effectiveness: Comparative analyses across regions* Paper presented at the Annual meeting of the American Educational Research Association, New Orleans, LA ERIC document ED 441 871
- Watson, J (2001) Profiling teachers' competence and confidence to teach particular mathematics topics: The case of chance and data *Journal of Mathematics Teacher Education*, 4 (4), 305-337
- Watson, J , & Chick, H (2002) A case study of graduate professional development in the TAFE sector *Australian Educational Researcher*, 29 (2), 73-91
- Wilson, D (2003) *Strategic analysis of the professional development needs of vocational education and training professionals in Queensland: Final report: Strategic professional development project* Brisbane: Queensland Department of Employment and Training